H8-Tiny SDK+

SystemDevelopmentKit for Hitachi H8/3664F

User Manual

PREFACE

Product Warranty
The warranty period against defects in materials and workmanship are as set out in the accompanying Customer Information sheet.

Limitation of Warranty
The foregoing warranty does not cover damage caused by fair wear and tear, abnormal storage conditions, incorrect use, accidental misuse, neglect, corruption, misapplication, addition or modification or by the use with other hardware or software, as the case may be, with witch the product is incompatible. No warranty of fitness for a particular purpose is offered. The user assumes the entire risk of using the product. Any liability of MSC Vertriebs GmbH is limited exclusively to the replacement of defective material or workmanship.

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Restrictions
Please refer to the restrictions of all components and tool suppliers.

Hardware Considerations
Grounding: This hardware is designed for use with equipment that is fully grounded. Ensure that all equipment used is appropriately grounded. Failure to do so could lead to danger for the operator or damage the equipment.
Electrostatic Discharge Precautions: This hardware contains devices that are sensitive to electrostatic discharge. Ensure appropriate precautions are observed during handling and accessing connections. Failure to do so could result in damage to the equipment.
Electromagnetic Compatibility: This product can cause radio frequency noise when used in the residential area. In such cases the user of the equipment my be required to take appropriate countermeasures under his responsibility.

Support
Support by MSC Vertriebs GmbH is provided only for the supplied hardware. Any software tools are supported from their supplier. Please notice that maybe some software tools coming with this kit are only unsupported freeware and no support will be given.
For MSC support please contact: TinyHelp@MSC-ge.com

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1 Overview

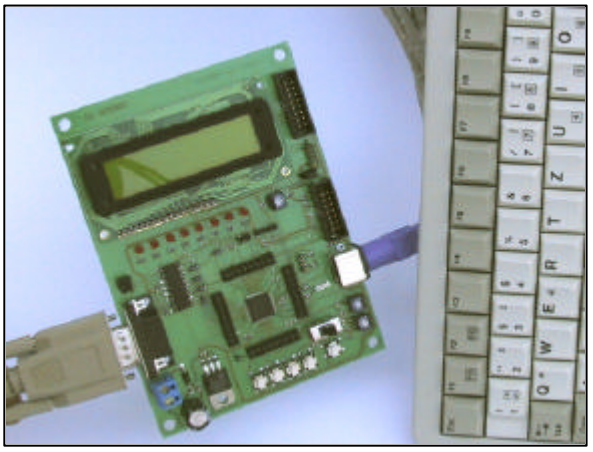
1.1 System Development Kit content

Thank you for purchasing our product. If you take care on the different hints in this manual you will have great success in software development with this microcontroller. Please refer to the documents listed in appendix.

The System Development Kit contains the following parts:

Evaluation-Board MSC-TEB1
CD-ROM
User manual (this document)
RS232 cable (1.8m, DSub9, male-female)

4 plastic feet for the MSC-TEB1



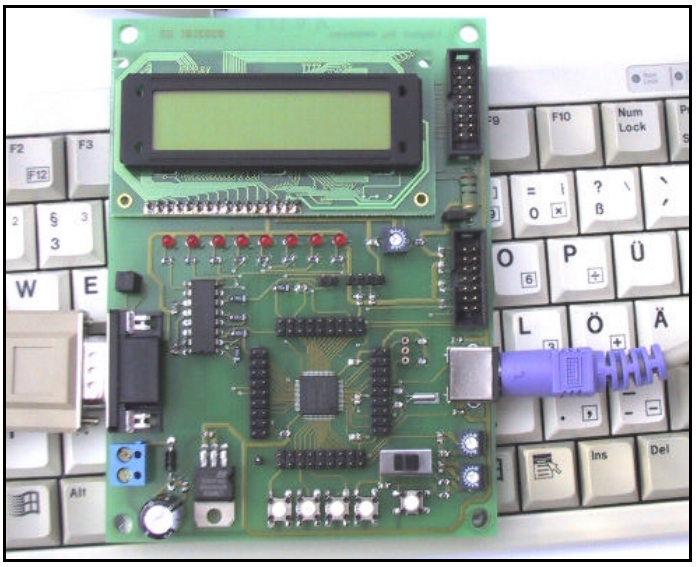
Carefully remove the board from the shipping carton. Check first if there are any damages before power on the evaluation board.

1.2 Hardware description

The Hitachi-Tiny-Eval-Board (MSC-TEB1) is a low cost multifunctional evaluation board for the Hitachi Tiny H8/3664F microcontroller. It can be used stand alone for software development and testing or as a simple target board. You can use the Flash-Download-Tool (FDT) for programming the target code or work with a debug system (E10T) at the provided connector. The board allows the designer immediately to start with the software development before his own final target system is available.

This eval-kit provides some additional hardware e.g. 8 LED's, a 2*16 Character LCD, 4 key's, a PC-AT-keyboard connector, an I2C-connector and more for hard- and software evaluation. All peripherals are used by some software application notes. Please refer chapter 3.

1.3 Features



- Contains H8/3664F microcontroller
- In-Circuit serial Flash programming
- All resources available for evaluation
- All pins routed to connectors
- 9.8304 MHz main crystal
- 32.768 kHz sub crystal
- UART interface with MAX232 level converter and SubD-9 (female) connector
- 8 User LEDs
- 2*16 characters LCD with LED backlight (switchable)
- Additional connector for external LCD
- 4 user keys
- PC-AT-Keyboard interface
- 2 potentiometer connected to A/D-channel 0/1
- Reset button
- 1 switch user/prog(programming)
- E10T-debug-connector
- +5V voltage regulator on board

1.4 Board overview

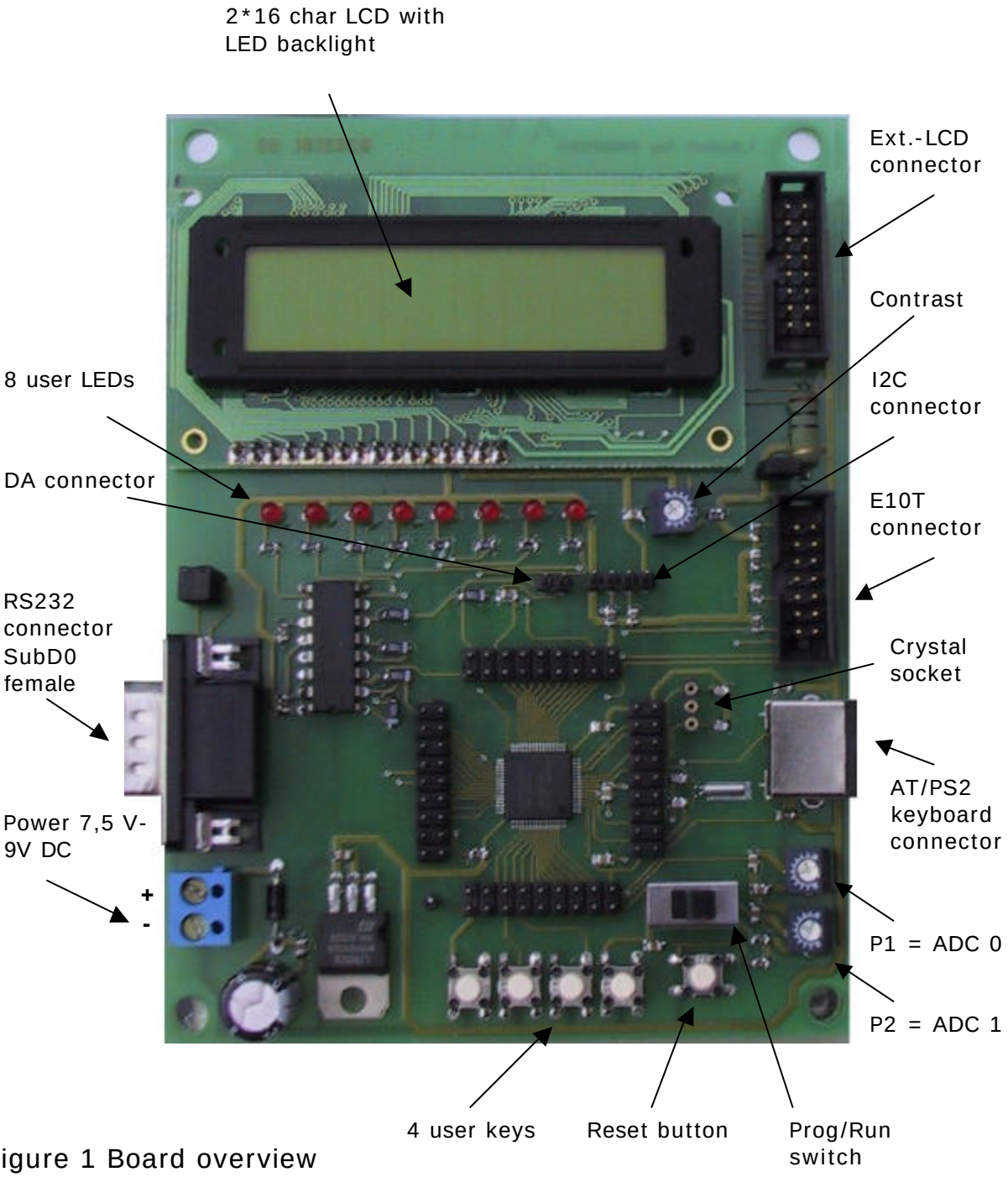
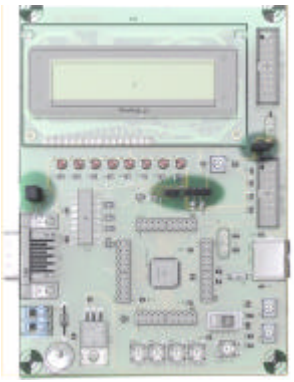


Figure 1 Board overview

1.5 Jumpers and switches



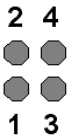
JP1 is used for switching the serial interface from 1:1 to crossed connection. If you connect a 1:1 cable (like the cable that comes with the kit) use the default setting. If you connect a crossed cable set the jumper to alternate setting.

JP3 is used for the LCD-LED backlight. If the jumper is closed (1-2) the backlight will be ON. Remove the jumper (=open) if backlight operation is not necessary.

JP2 is used for I2C interface

JP4 is used as an output for the DAC or for PWM

JP1	Operation
1-3, 2-4	1:1 operation
1-2, 3-4	Crossed connection



JP3	Operation
Closed	LED backlight ON
Open	LED backlight OFF

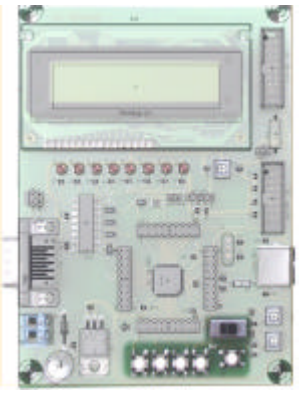
JP2, I2C-CON	Operation
1	+5V
2	SDA
3	SCL
4	GND

JP4, D/A CON	Operation
1	D/A Output (PWM)
2	GND

S_PROG/RUN switches between RUN- and PROG(PROGRAMMING) mode.

KEY_1 (T1) to KEY_4 (T4) are user keys.

RESET_KEY (T7) is for reset.



Orientation	Operation
LEFT	PROG(programming) mode
RIGHT	RUN mode

Main crystal (Q1) can be changed to another frequency. Therefore a crystal socket is provided. Please refer to the microcontroller hardware documentation for recommended devices. The crystal type should be a HC49 / HC49U type. Eventually change the capacitors C6/C7 if necessary. If you change the crystal frequency take care on possible changes by flash download tool (see FDT manual).

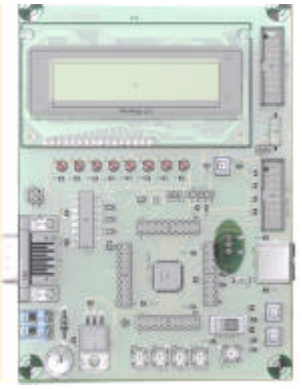
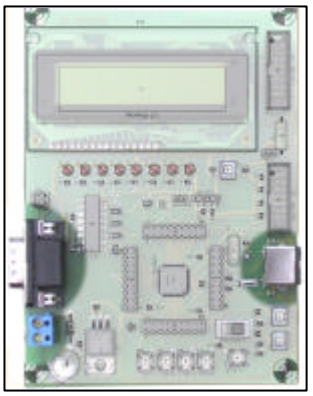


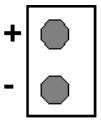
Figure 1.5 crystal socket

1.6 Connectors



X1, Serial communication, SubD-9 female
X2, Power connector, for cable connection
X4, MiniDIN (PS2)

X2, Pin	Operation
1	GND
2	DC power supply, 7,5 – 9 VDC, approx. 180mA with LED backlight

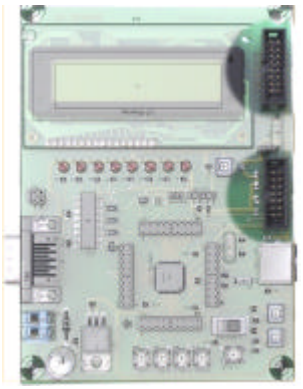


X1 (SubD9), Pin	Operation	Remark
1	(DTR,DSR, DTS)	Connected to X1.4, X1.6
2	TXD	Connected to JP1.1
3	RXD	Connected to JP1.3
4	DTR	Connected to X1.1, X1.6
5	GND	
6	DSR	Connected to X1.1, X1.4
7	RTS	Connected to X1.8
8	CTS	Connected to X1.7
9	n.c.	Not connected

X4 (Mini-Din) Pin	µC-Pin	Operation
1	P17	(can be Data or Clk)
5	P16	(can be Clk or Data)
3		GND
4		Vcc
2,6		n.c.

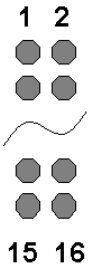
OnBoard LCD (IC4)
X3, external LCD-connector (057-016-1)

X5, E10T debug connector (Sys-Con)



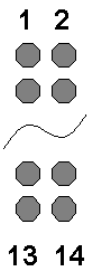
LCD Modul (IC4) pin	X3 (LCD-CON) (057-016-1) pin	µC-pin	Operation
3	1	-	GND
4	2	-	Vcc
5	3	-	contrast (=P3)
6	4	P75	RS (register select)
7	5	P74	R/W (read / write)
8	6	P20	EN (enable)
9	7	P50	D0
10	8	P51	D1
11	9	P52	D2
12	10	P53	D3
13	11	P54	D4
14	12	P55	D5
15	13	P56	D6
16	14	P57	D7
1	15	-	Backlight +
2	16	-	GND

X3 pinout

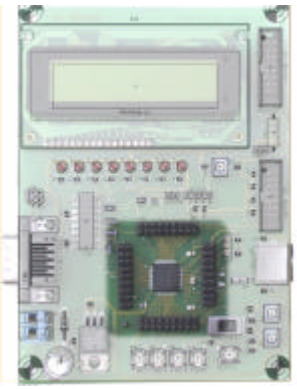


X5 (SYS-CON), pin	µC-pin	Operation
1	P87	Debug pin
5	P86	Debug pin
7	/NMI	/NMI
11	P85	Debug pin
13	/RESET	reset control
8	Vcc	
2,4,6,10,12,14	GND	
3,9	n.c.	Not connected

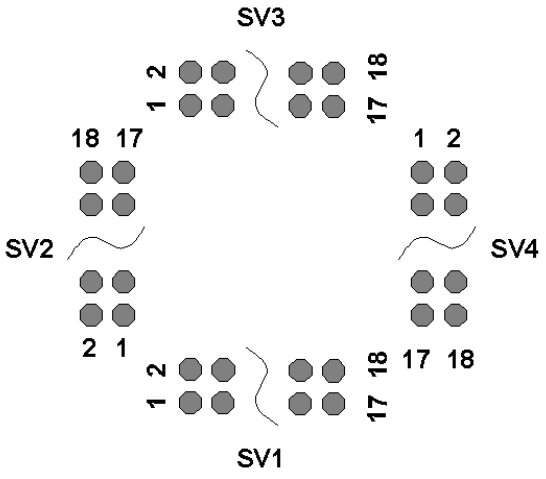
X5 pinout



SV1,SV2, SV3,SV4 connectors with microcontroller signals



SV1		SV2		SV3		SV4	
PIN	**Operation**	**PIN**	**Operation**	**PIN**	**Operation**	**PIN**	**Operation**
1,2	GND	1,2	GND	1,2	GND	1,2	GND
3	n.c.	3	n.c.	3	n.c.	3	P51
4	n.c.	4	n.c.	3	n.c.	4	P50
5	P14	5	P22	5	P76	5	n.c.
6	P15	6	P21	6	P75	6	n.c.
7	P16	7	P20	7	P74	7	n.c.
8	P17	8	P87	8	P57	8	n.c.
9	AN4	9	P86	9	P56	9	n.c.
10	AN5	10	P85	10	P12	10	n.c.
11	AN6	11	P84	11	P11	11	n.c.
12	AN7	12	P83	12	P10	12	n.c.
13	AN3	13	P82	13	P55	13	GND
14	AN2	14	P81	14	P54	14	/RESET
15	AN1	15	P80	15	P53	15	VCL
16	AN0	16	/NMI	16	P52	16	n.c.
17,18	Vcc	17,18	Vcc	17,18	Vcc	17,18	Vcc



1.7 Start-Up instructions

1.7.1 Installing the MSC-TEB1

Installing the MSC-TEB1 requires a power supply and a serial connection to a host computer (common PC). The serial communications cable for connecting the MSC-TEB1 to a host computer is supplied and has 1:1 connectivity.

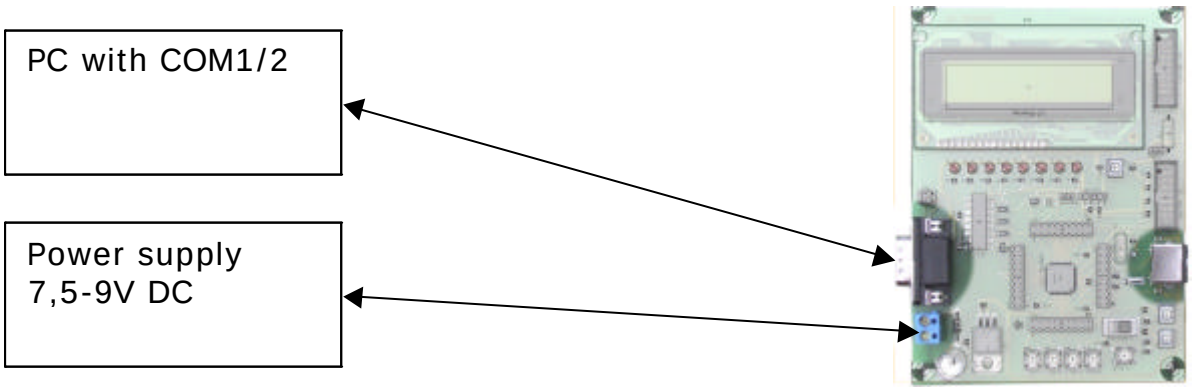


Figure 1.8 shows how to connect the MSC-TEB1 to a PC and to a power supply

1.7.2 Power Supply

The MSC-TEB1 hardware requires a power supply of 7,5V DC at minimum. Please don't use a power supply with more the 9V DC because the on board voltage regulator becomes very hot!

The MSC-TEB1 power consumption is about 180mA with LCD-backlight ON. Since total power consumption can vary widely due to external connectors, H8/3664F port state, use a power supply capable of providing at least 300mA at +7,5V DC.

The design includes circuitry for reversed polarity protection.

Please watch on GND (ground) connection between power supply, eval-board and PC.

1.7.3 Test program

The MSC-TEB1 is supplied with a short demo application when delivered. If you power up the eval-board for the first time, you will see a start up message and some LEDs lighting.

If no message appear, please set the switch “Prog/Run” to “Run-Mode” (right position) and power up the board or, if already done, press the reset-button.

The demo application contains a small “Running-Light” application. The keys can be used for control the state, P2 is used as speed control. First press the key T3 (RUN) for starting demo application. Then you can check the functionality by pressing the keys KEY T1 to KEY T4 or change the value of potentiometer P2.

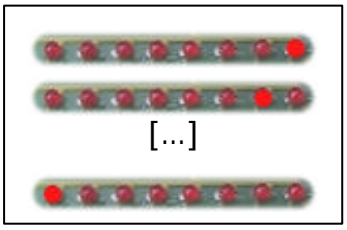


Figure of the Demo application. “Running Light”

Any time you want to reset the application press the reset-button. If you want to reload the demo application later (after reprogrammed the eval-board) you can find the code on CD-R in the directory “X:\Demo\Flashdemo\runlight.a37” (For X use the appropriate char from your CD-ROM).

1.7.4 Software Installation

Software development on MSC-TEB1 requires some software tools to be installed on your PC. All tools can be found on CD-R. Some of them must be installed separately. Please refer on installation / setup requirements.

You will find the following (necessary) tools:

HEW: Hitachi Embedded Workbench with a full version of the MSC-C/C++ compiler for all Hitachi Tiny controllers, assembler and linker and library generator

FDT: A powerful freeware flash tool (flash-writer) from HMSE

CodeLines: Code generator tool for device driver generation from HMSE

Installation hints:

HEW: First install HEW (setup.exe in directory HEW). Follow the instructions in setup and look at the readme.txt file.

FDT: Next install ftd15.exe. Then the plugin fdt3664f.exe must be installed. Follow the setup instructions. A documentation will be found in fdt_man.pdf.

CodeLines: Optionally CodeLines can be installed (setup.exe in directory CodeLines)

If you have installed these tools please refer to the next lessons for workflow.

NOTE: Most freeware tools are unsupported versions! Please refer to manuals or hints on website for FAQ's!

It is strongly recommended to refer all additional documents like H8/3664F hardware manual and H8 programming manual. Please see the application notes and several readme files on CD-R. Sometimes you should watch on the Hitachi, HMSE and IAR websites for tool upgrading, news and latest versions of all tools.

Hitachi: www.hitachi-eu.com/semiconductors
HMSE: www.hmse.com

2 Development Environment

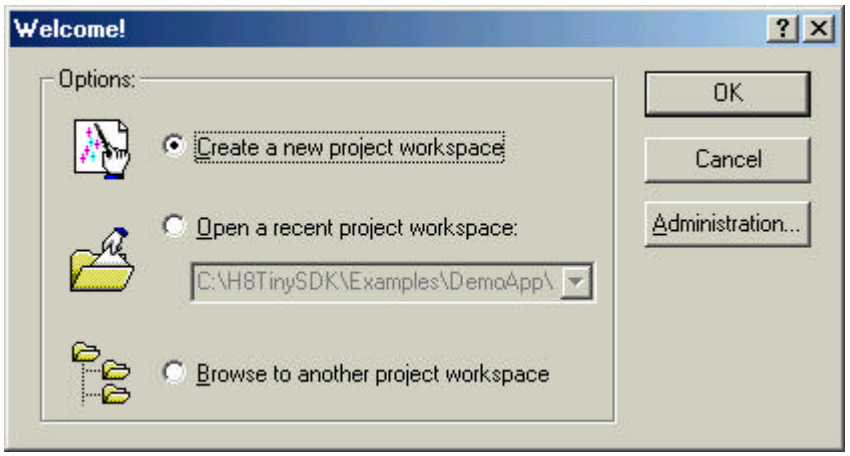
2.1 Create a program using HEW

Software development can be done with the integrated embedded workbench like HEW. This software contains an editor, some tools for organisation and a tool chain for compiling, assembling and linking programs.

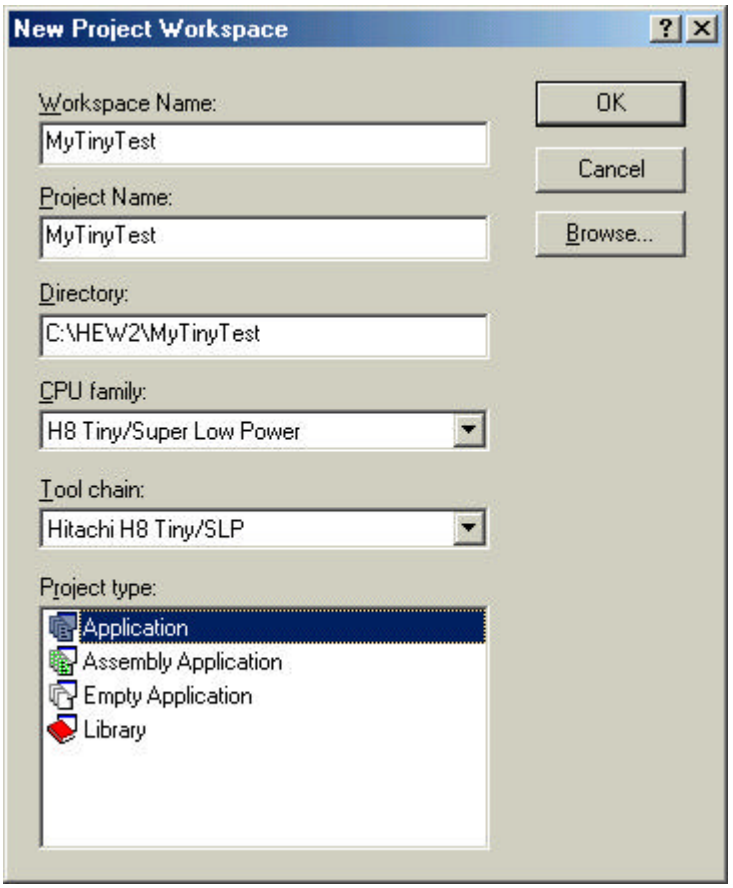
There is a full version of the HEW tool chain for H8/Tiny microcontrollers from HMSE included.

For create new project please follow the next Steps:

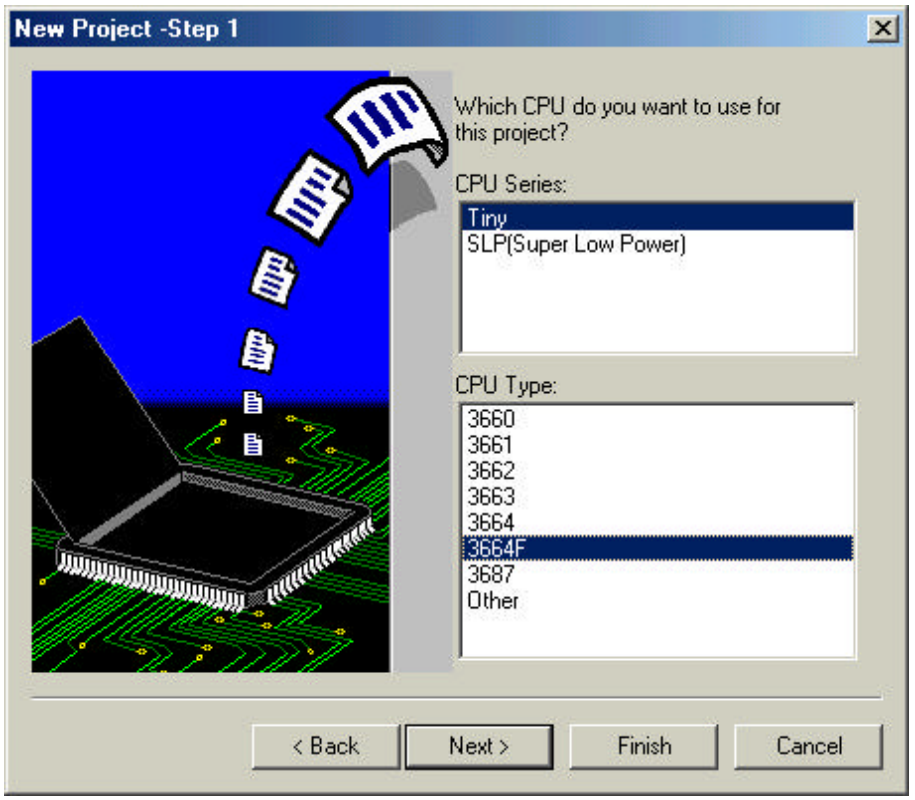
Start HEW and create a new workspaces:



select “create a new project workspace”, click „OK“ and type in the (project-) name.

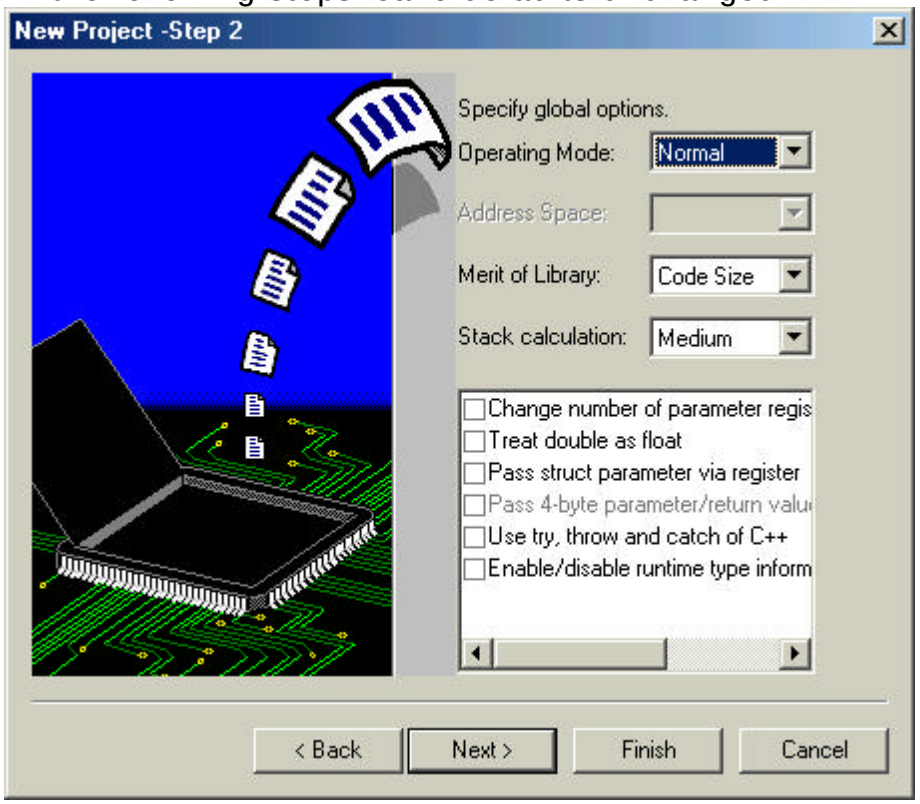


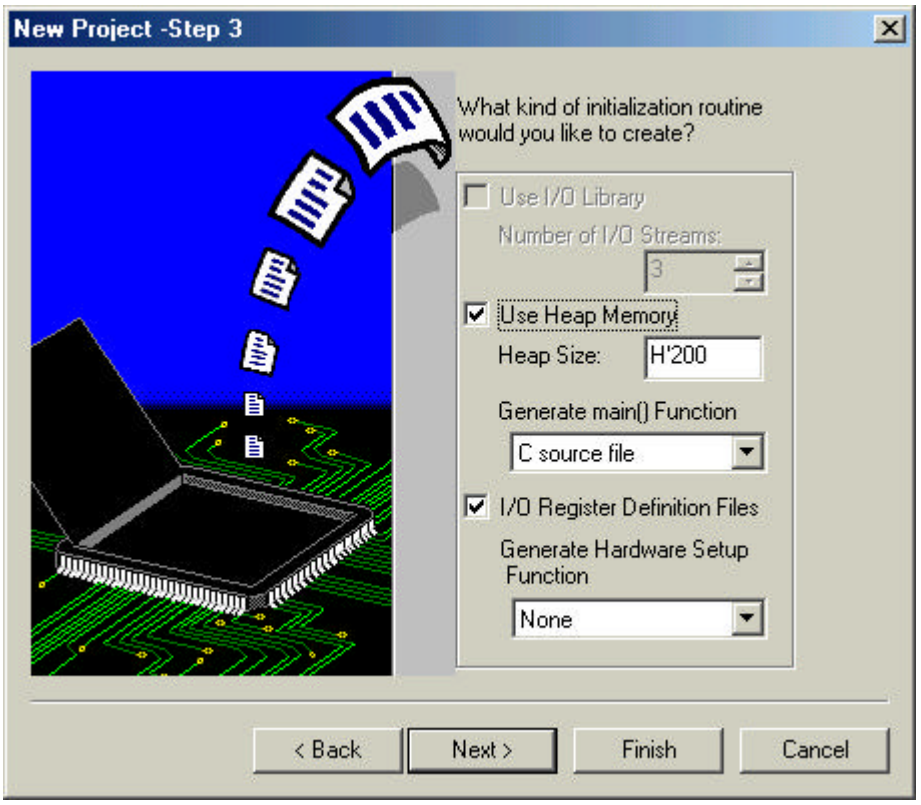
Here the project name is “MyTinyTest“. A project directory will be added automatically but can be changed manually – please use the defaults here. CPU-family is H8 Tiny/Super Low Power. Click “OK” when ready.

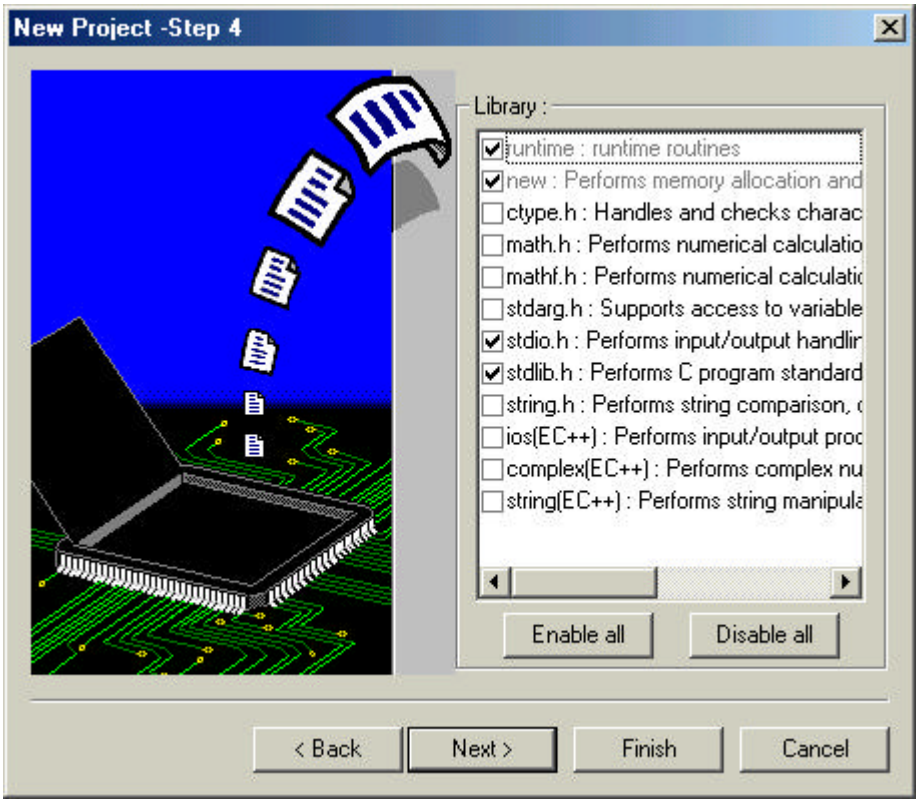


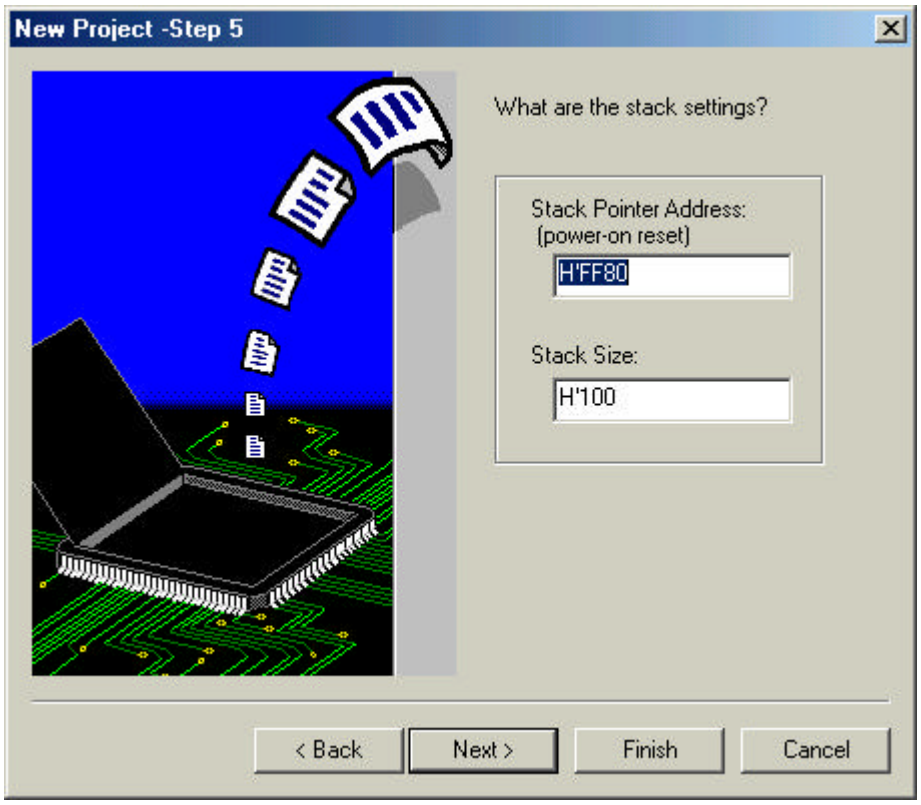
First select CPU series = „Tiny". CPU is 3664F. Then click "next".

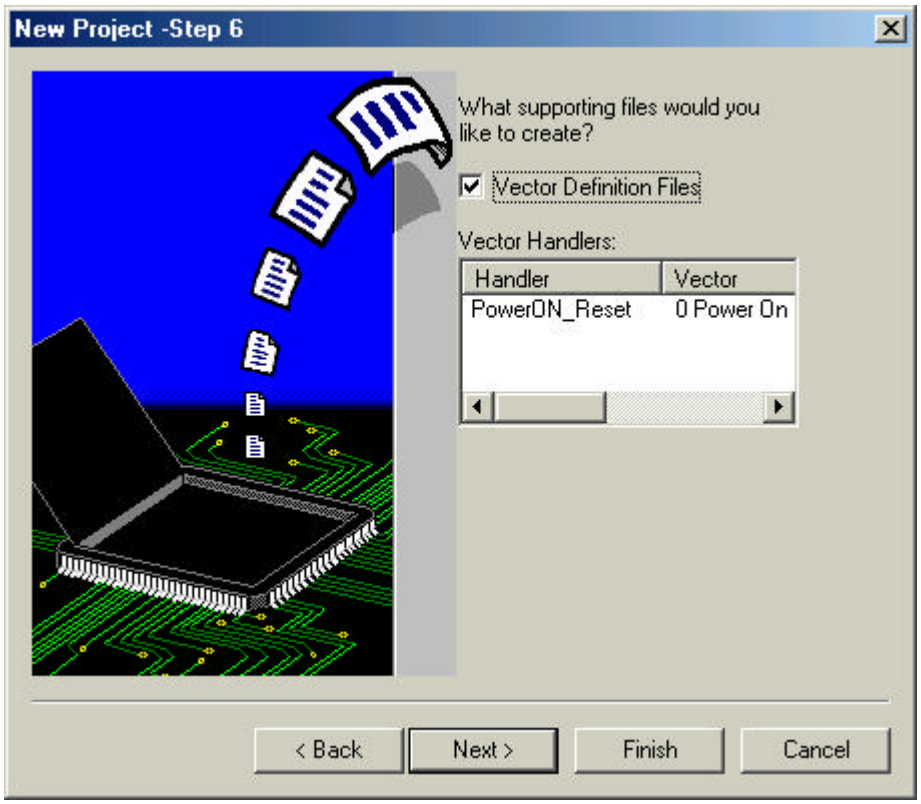
In the following steps leave defaults unchanged.

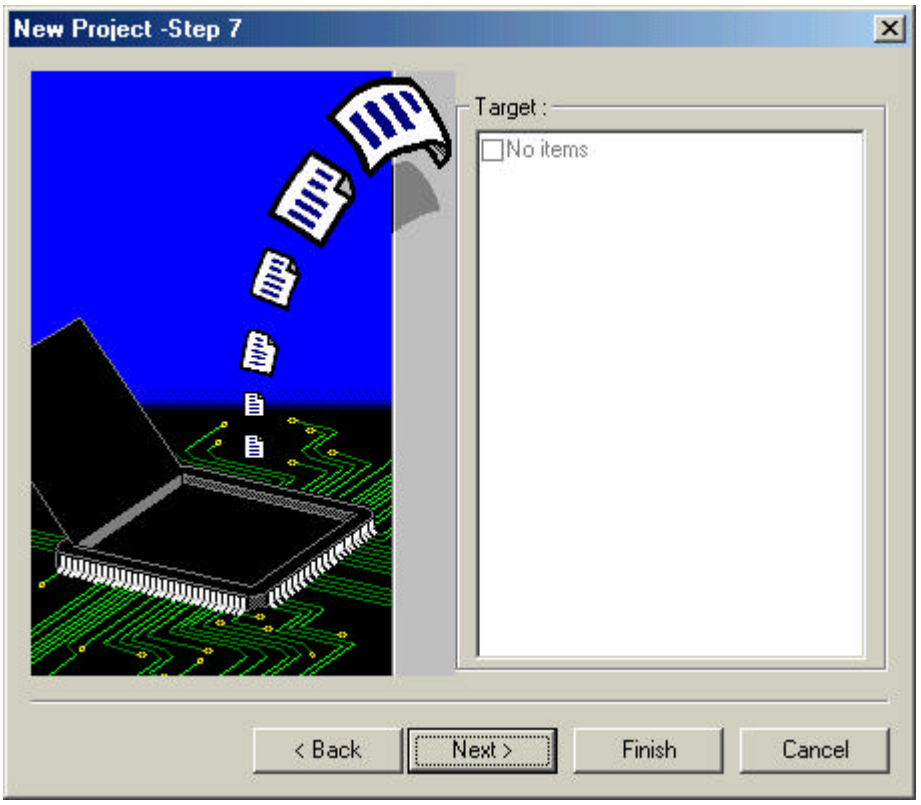



New Project -Step 3
What kind of initialization routine would you like to create?
Use I/O Library
Number of I/O Streams:
3
Use Heap Memory
Heap Size:
H'200
Generate main() Function
C source file
I/O Register Definition Files
Generate Hardware Setup Function
None
< Back
Next >
Finish
Cancel

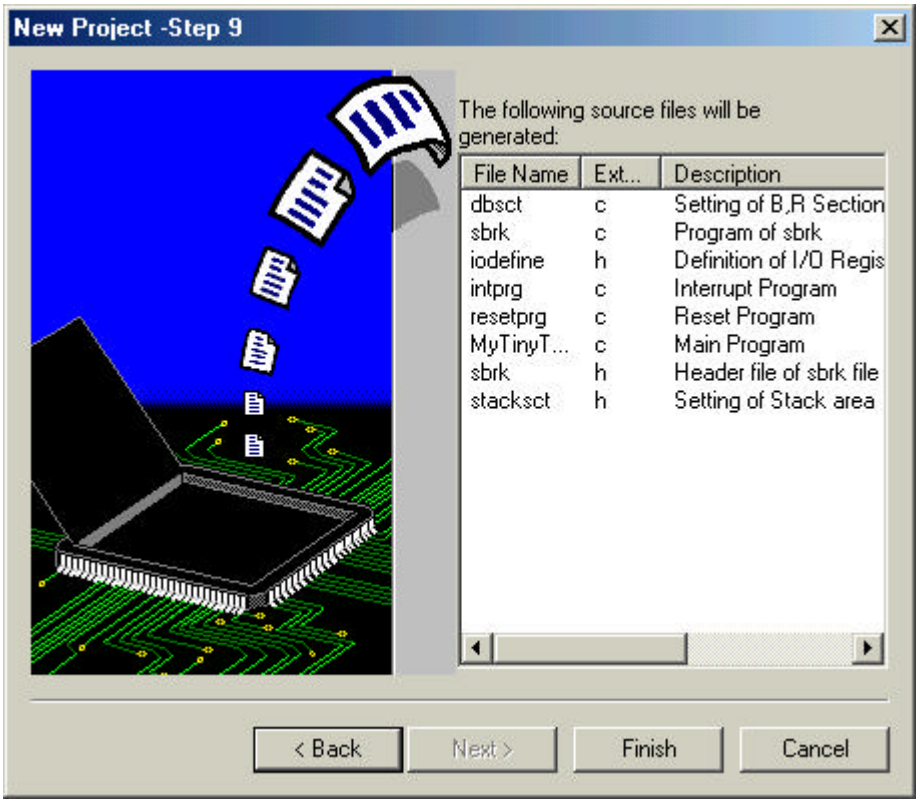

New Project -Step 4
Library :
runtime : runtime routines
new : Performs memory allocation and
ctype.h : Handles and checks charac
math.h : Performs numerical calculatio
mathf.h : Performs numerical calculatic
stdarg.h : Supports access to variable
stdio.h : Performs input/output handlir
stdlib.h : Performs C program standard
string.h : Performs string comparison,
ios(EC++) : Performs input/output proc
complex(EC++) : Performs complex nu
string(EC++) : Performs string manipula
Enable all
Disable all
< Back
Next >
Finish
Cancel


New Project -Step 5
What are the stack settings?
Stack Pointer Address:
(power-on reset)
H'FF80
Stack Size:
H'100
< Back
Next >
Finish
Cancel

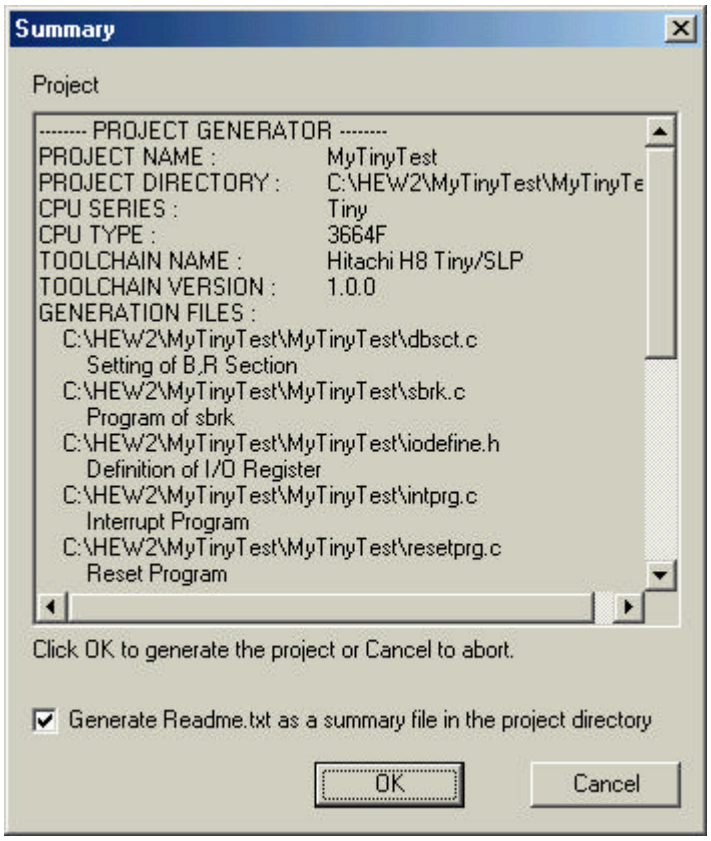

New Project -Step 6
What supporting files would you like to create?
Vector Definition Files
Vector Handlers:
Handler
Vector
PowerON_Reset
0 Power On
< Back
Next >
Finish
Cancel



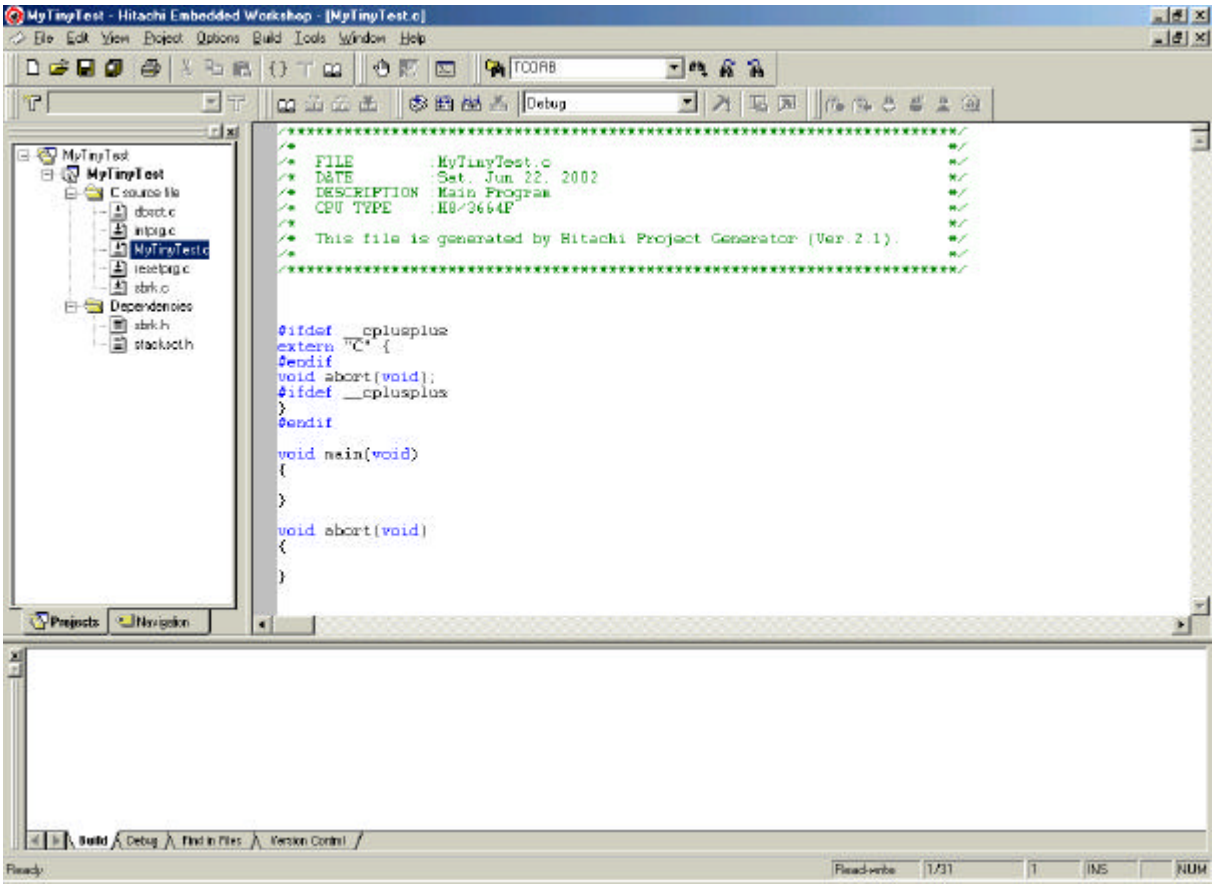
(missing step 8 her is ok!)



In step 9 click “Finish” and a project report will be displayed:



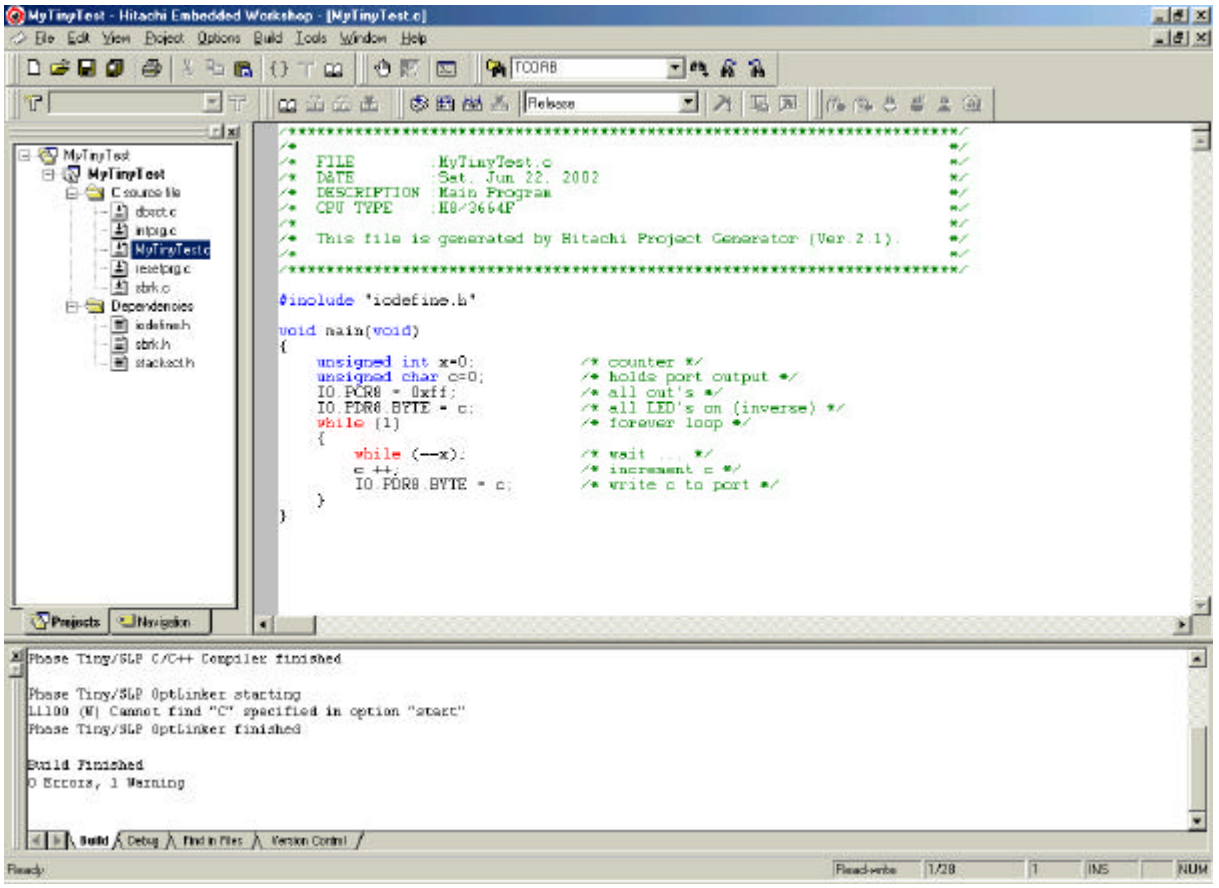
Click “ok” and the new workspace is well prepared. At the left side you can see the structure of your project with all files. A double click on ‘C source file’ / …\MyTinyTest.c will open the file to the right window.



Please first save your project with file/save.

Now type in the following program:

```
/************************************************************************/
/*                                                                      */
/*  FILE        :MyTinyTest.c                                           */
/*  DATE        :Sat, Jun 22, 2002                                      */
/*  DESCRIPTION :Main Program                                           */
/*  CPU TYPE    :H8/3664F                                               */
/*                                                                      */
/*  This file is generated by Hitachi Project Generator (Ver.2.1).      */
/*                                                                      */
/************************************************************************/

#include "iodefine.h"

void main(void)
{
    unsigned int x=0;               /* counter */
    unsigned char c=0;              /* holds port output */
    IO.PCR8 = 0xff;                         /* all out's */
    IO.PDR8.BYTE = c;               /* all LED's on (inverse) */
    while (1)                               /* forever loop */
    {
        while (--x);                /* wait ... */
        c ++;                               /* increment c */
        IO.PDR8.BYTE = c;           /* write c to port */
    }
}
```



Now select “release”. With “Build All” (or F7 = Build) the project will be compiled and linked. If there are no errors the message window shows:

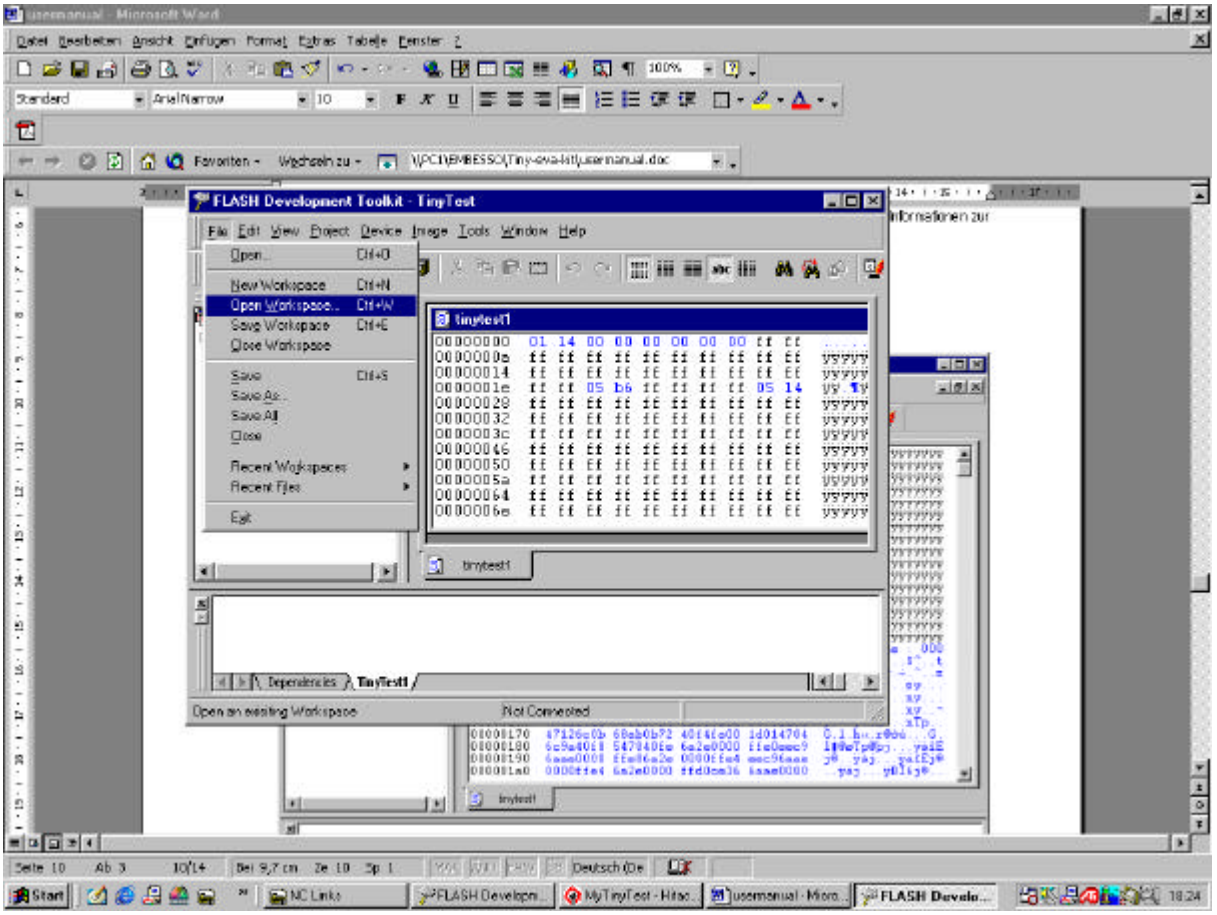
```
Building - MyTinyTest - Release

Phase Tiny/SLP C/C++ Library Generator starting
Nothing to do - skipping
Phase Tiny/SLP C/C++ Library Generator finished

Phase Tiny/SLP C/C++ Compiler starting
Nothing to do - skipping
Phase Tiny/SLP C/C++ Compiler finished

Phase Tiny/SLP OptLinker starting
Nothing to do - skipping
Phase Tiny/SLP OptLinker finished

Build Finished
0 Errors, 0 Warnings
```

Please follow the steps in the next section: Download the target file in the controller flash.

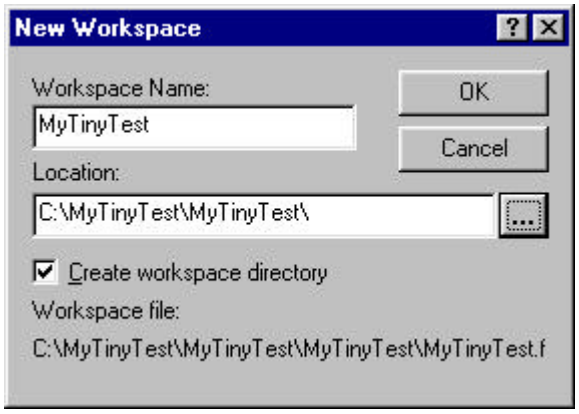
2.2 Download the code using FDT

After compiling and linking (error free!), the target code (mytinytest.d37) should be downloaded to target board. Therefore we use a freeware tool from HMSE : **FDT**.

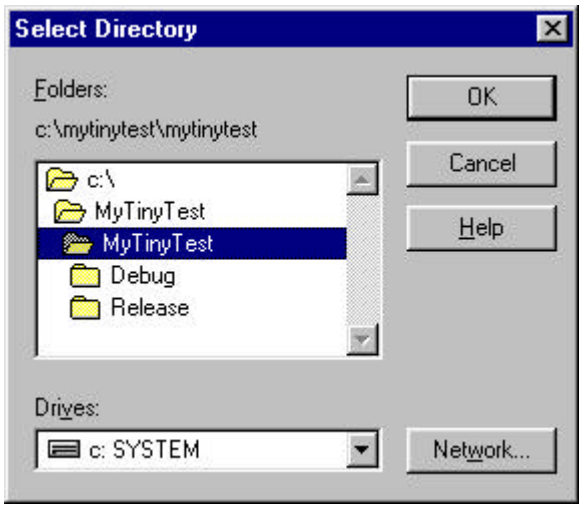
Even FDT must be prepared for a new workspace.



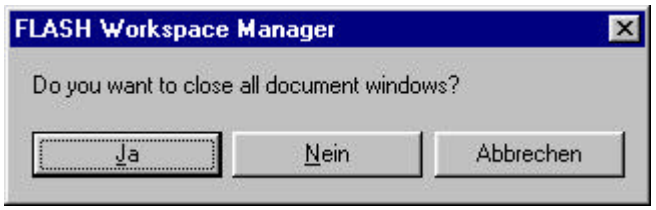
Please start FDT and select „New Workspace“. Here we use the project name “MyTinyTest”.



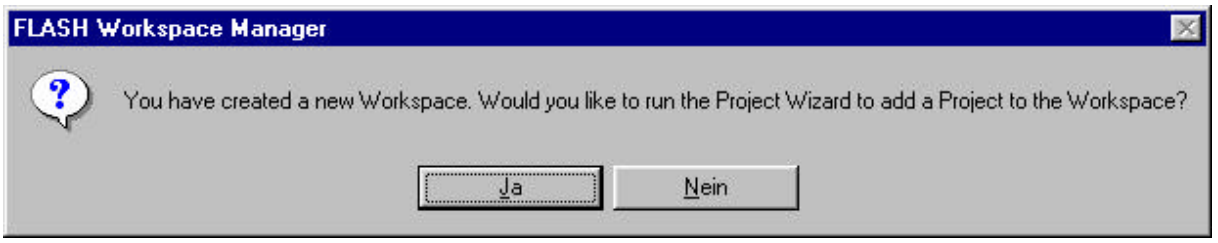
You can choose a location for all workspace files. Select on subdirectory from „MyTinyTest“.



Click ok and a further window will appear:

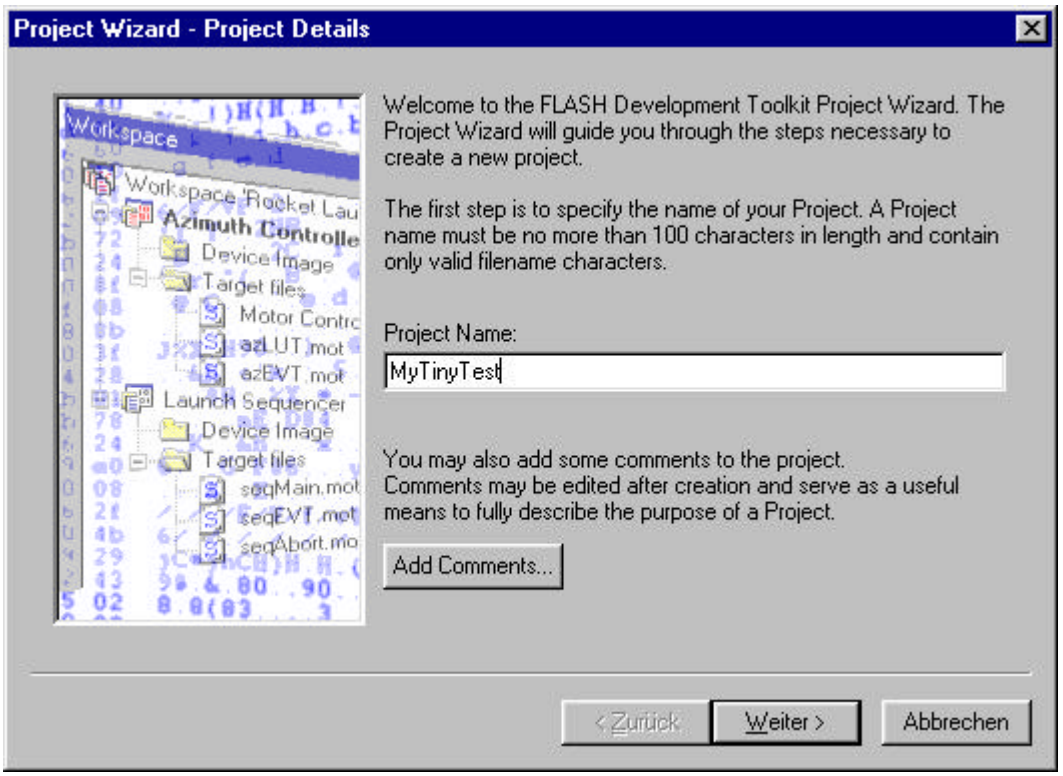


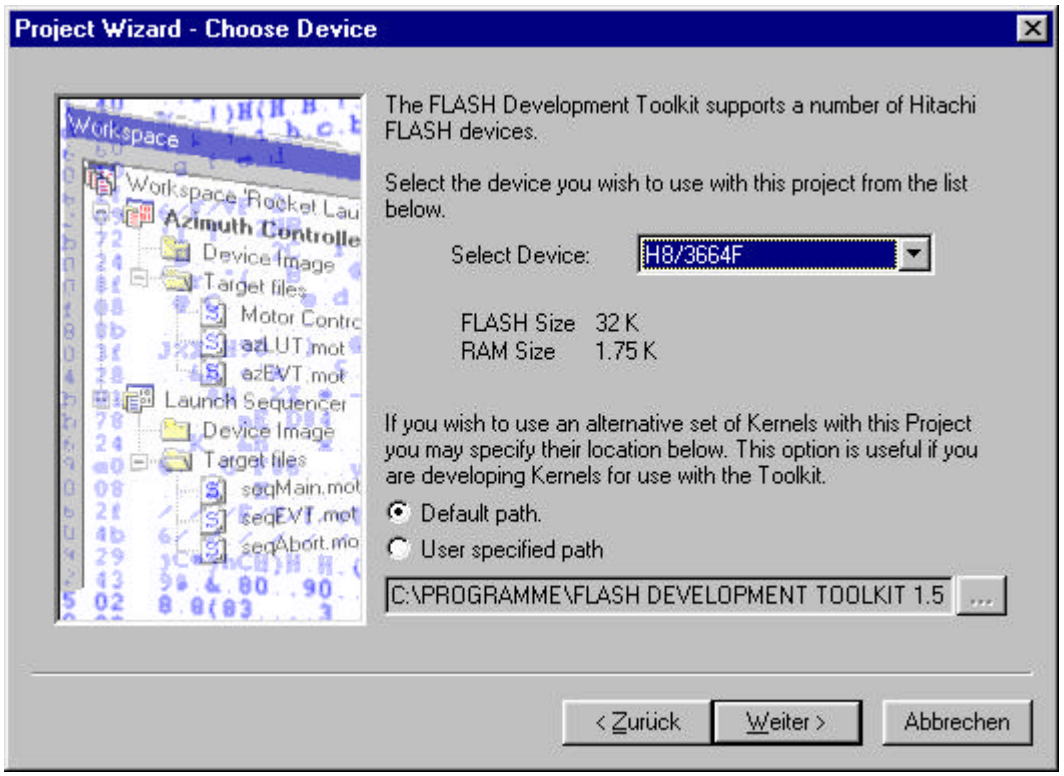
Select „Yes“

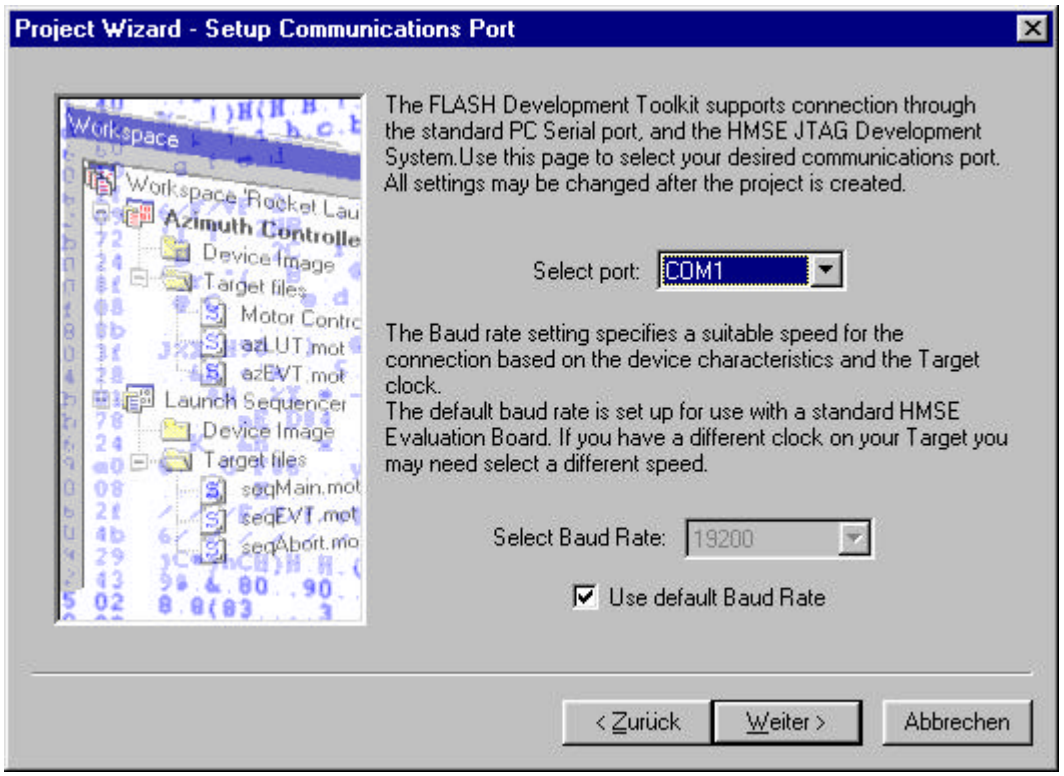

FLASH Workspace Manager
You have created a new Workspace. Would you like to run the Project Wizard to add a Project to the Workspace?
Ja
Nein

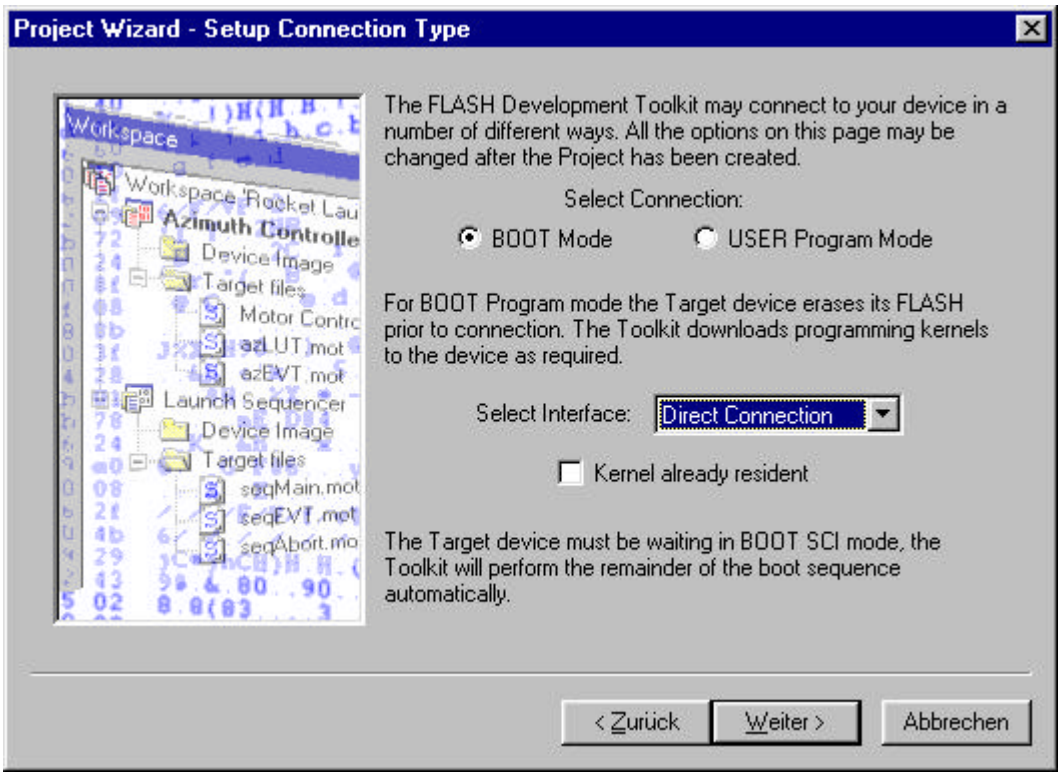
First time users should use the wizard!

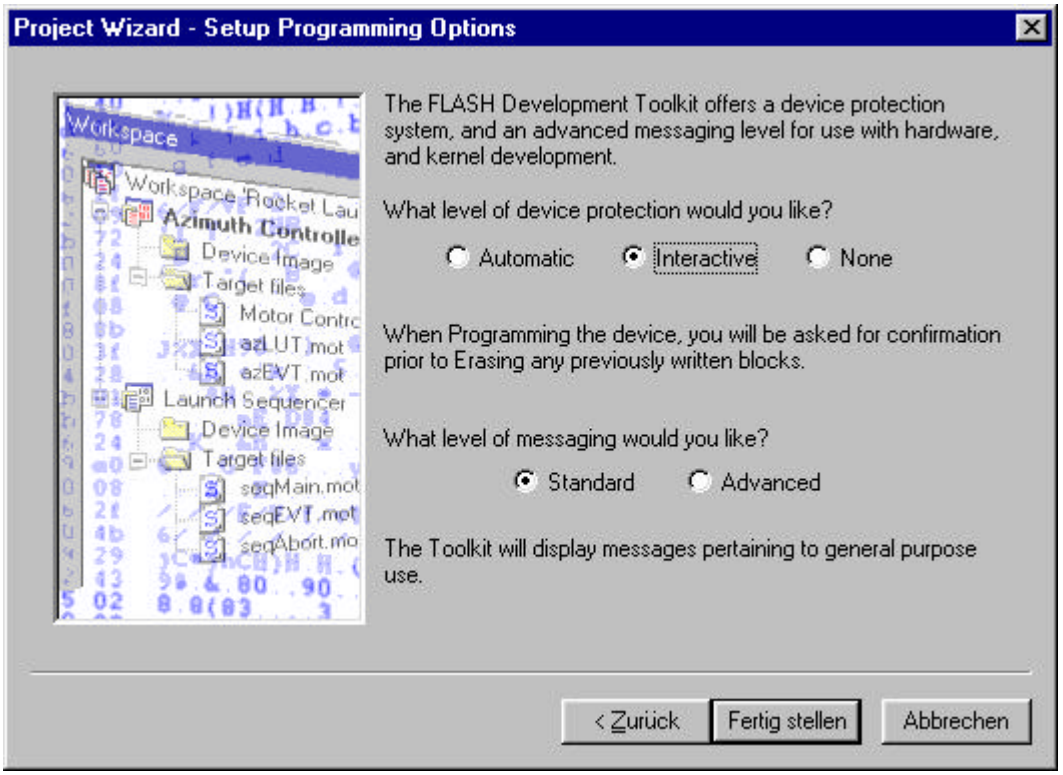
Fill in the following things:

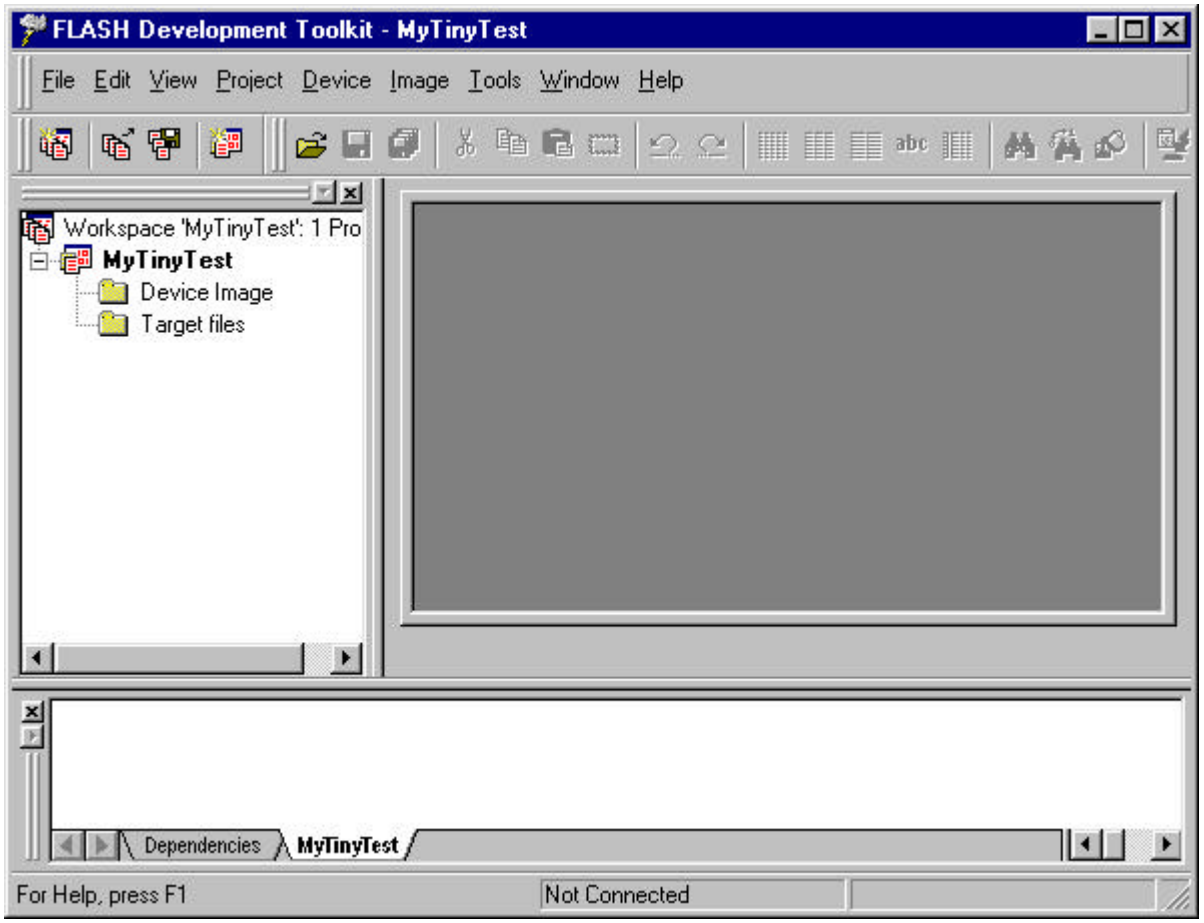

Project Wizard - Project Details
Workspace
Workspace 'Rocket Lau
Azimuth Controlle
Device Image
Target files
Motor Contrc
azLUT.mot
azEVT.mot
Launch Sequencer
Device Image
Target files
seqMain.mot
seqEVT.mot
seqAbort.mo
Welcome to the FLASH Development Toolkit Project Wizard. The Project Wizard will guide you through the steps necessary to create a new project.
The first step is to specify the name of your Project. A Project name must be no more than 100 characters in length and contain only valid filename characters.
Project Name:
MyTinyTest
You may also add some comments to the project. Comments may be edited after creation and serve as a useful means to fully describe the purpose of a Project.
Add Comments...
< Zurück
Weiter >
Abbrechen


Project Wizard - Choose Device
Workspace
Workspace 'Rocket Lau
Azimuth Controlle
Device Image
Target files
Motor Contro
azLUT.mot
azEVT.mot
Launch Sequencer
Device Image
Target files
seqMain.mot
seqEVT.mot
seqAbort.mo
The FLASH Development Toolkit supports a number of Hitachi FLASH devices.
Select the device you wish to use with this project from the list below.
Select Device:
H8/3664F
FLASH Size 32 K
RAM Size 1.75 K
If you wish to use an alternative set of Kernels with this Project you may specify their location below. This option is useful if you are developing Kernels for use with the Toolkit.
Default path.
User specified path
C:\PROGRAMME\FLASH DEVELOPMENT TOOLKIT 1.5
...
< Zurück
Weiter >
Abbrechen


Project Wizard - Setup Communications Port
Workspace
Workspace 'Rocket Lau
Azimuth Controlle
Device Image
Target files
Motor Contro
azLUT.mot
azEVT.mot
Launch Sequencer
Device Image
Target files
seqMain.mot
seqEVT.mot
seqAbort.mo
The FLASH Development Toolkit supports connection through the standard PC Serial port, and the HMSE JTAG Development System.Use this page to select your desired communications port. All settings may be changed after the project is created.
Select port:
COM1
The Baud rate setting specifies a suitable speed for the connection based on the device characteristics and the Target clock.
The default baud rate is set up for use with a standard HMSE Evaluation Board. If you have a different clock on your Target you may need select a different speed.
Select Baud Rate:
19200
Use default Baud Rate
< Zurück
Weiter >
Abbrechen

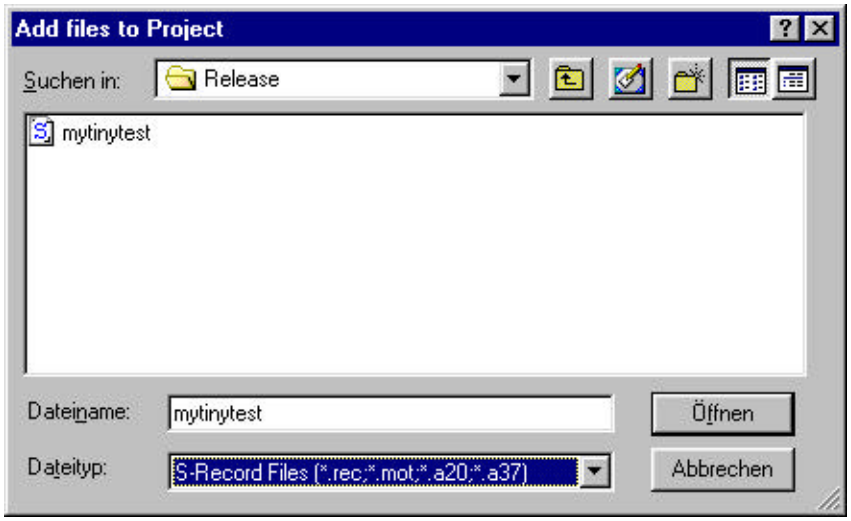

Project Wizard - Setup Connection Type
Workspace
Workspace 'Rocket Lau
Azimuth Controlle
Device Image
Target files
Motor Contrc
azLUT.mot
azEVT.mot
Launch Sequencer
Device Image
Target files
seqMain.mot
seqEVT.mot
seqAbort.mo
The FLASH Development Toolkit may connect to your device in a number of different ways. All the options on this page may be changed after the Project has been created.
Select Connection:
BOOT Mode
USER Program Mode
For BOOT Program mode the Target device erases its FLASH prior to connection. The Toolkit downloads programming kernels to the device as required.
Select Interface:
Direct Connection
Kernel already resident
The Target device must be waiting in BOOT SCI mode, the Toolkit will perform the remainder of the boot sequence automatically.
< Zurück
Weiter >
Abbrechen


Project Wizard - Setup Programming Options
Workspace
Workspace 'Rocket Lau
Azimuth Controlle
Device Image
Target files
Motor Contrc
azLUT.mot
azEVT.mot
Launch Sequencer
Device Image
Target files
seqMain.mot
seqEVT.mot
seqAbort.mo
The FLASH Development Toolkit offers a device protection system, and an advanced messaging level for use with hardware, and kernel development.
What level of device protection would you like?
Automatic
Interactive
None
When Programming the device, you will be asked for confirmation prior to Erasing any previously written blocks.
What level of messaging would you like?
Standard
Advanced
The Toolkit will display messages pertaining to general purpose use.
< Zurück
Fertig stellen
Abbrechen

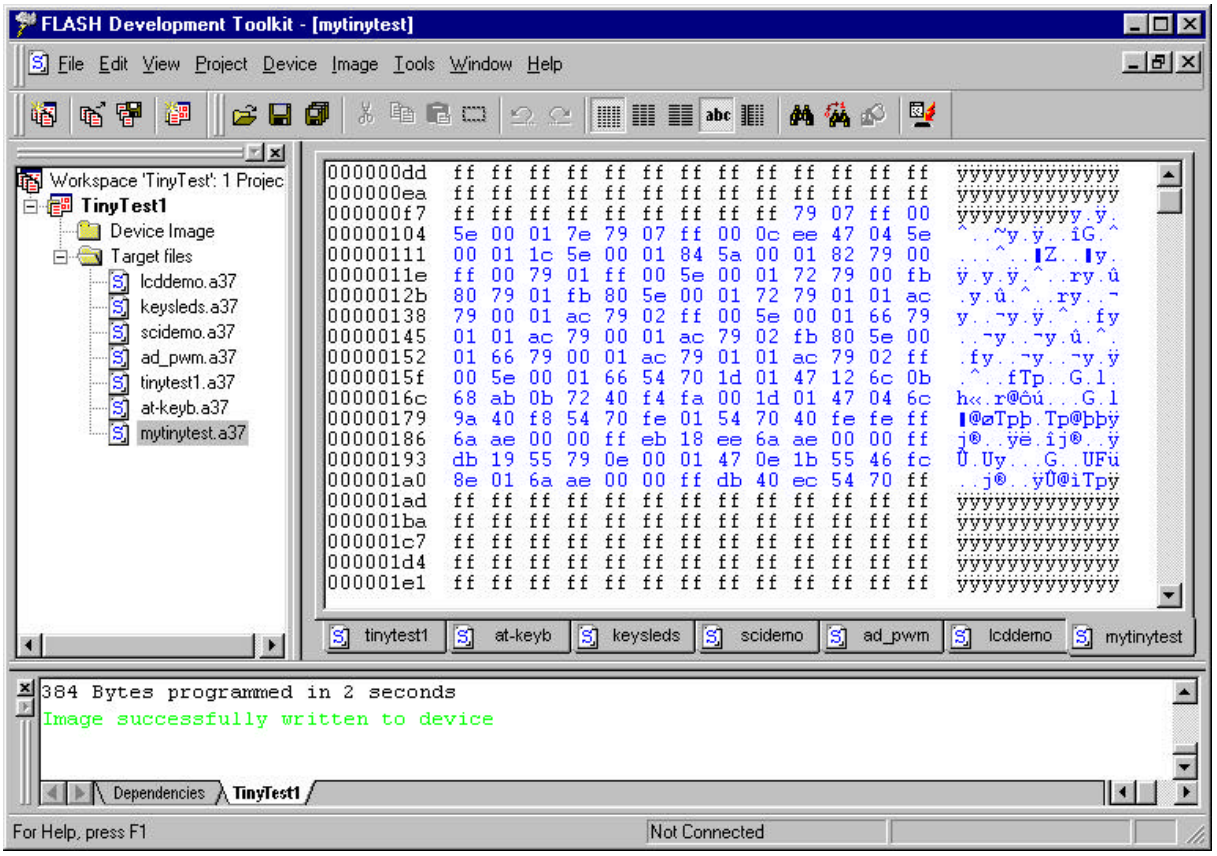


Now a workspace is created and you can add your target file to „TargetFiles“:

Select Project/Add new files to project... and search for file: c:\hew2\mytinytest\mytinytest\release\mytinytest.mot.



Now make a double click on \targetfiles\mytinytest and the file content of mytinytest.mot will appear in hex format in the right window.


FLASH Development Toolkit - [mytinytest]
File Edit View Project Device Image Tools Window Help
Workspace 'TinyTest': 1 Projec
TinyTest1
Device Image
Target files
lcddemo.a37
keysleds.a37
scidemo.a37
ad_pwm.a37
tinytest1.a37
at-keyb.a37
mytinytest.a37
000000dd ff ff ff ff ff ff ff ff ff ff ff ff ff
000000ea ff ff ff ff ff ff ff ff ff ff ff ff ff
000000f7 ff ff ff ff ff ff ff ff ff 79 07 ff 00
00000104 5e 00 01 7e 79 07 ff 00 0c ee 47 04 5e
00000111 00 01 1c 5e 00 01 84 5a 00 01 82 79 00
0000011e ff 00 79 01 ff 00 5e 00 01 72 79 00 fb
0000012b 80 79 01 fb 80 5e 00 01 72 79 01 01 ac
00000138 79 00 01 ac 79 02 ff 00 5e 00 01 66 79
00000145 01 01 ac 79 00 01 ac 79 02 fb 80 5e 00
00000152 01 66 79 00 01 ac 79 01 01 ac 79 02 ff
0000015f 00 5e 00 01 66 54 70 1d 01 47 12 6c 0b
0000016c 68 ab 0b 72 40 f4 fa 00 1d 01 47 04 6c
00000179 9a 40 f8 54 70 fe 01 54 70 40 fe fe ff
00000186 6a ae 00 00 ff eb 18 ee 6a ae 00 00 ff
00000193 db 19 55 79 0e 00 01 47 0e 1b 55 46 fc
000001a0 8e 01 6a ae 00 00 ff db 40 ec 54 70 ff
000001ad ff ff ff ff ff ff ff ff ff ff ff ff ff
000001ba ff ff ff ff ff ff ff ff ff ff ff ff ff
000001c7 ff ff ff ff ff ff ff ff ff ff ff ff ff
000001d4 ff ff ff ff ff ff ff ff ff ff ff ff ff
000001e1 ff ff ff ff ff ff ff ff ff ff ff ff ff
tinytest1
at-keyb
keysleds
scidemo
ad_pwm
lcddemo
mytinytest
384 Bytes programmed in 2 seconds
Image successfully written to device
Dependencies
TinyTest1
For Help, press F1
Not Connected

First press the reset button at the target board, hold it down and move Prog/Run-switch to prog position (left). After that release the reset button.

With Image/Download image (Ctrl-P) you one can start the connection setup to target board and start downloading image file.

Now press Ctrl-P (Download) on FDT and the download process will start. Watch on progress bar while download.

When the download is finished press Alt-C to disconnect the PC connection.

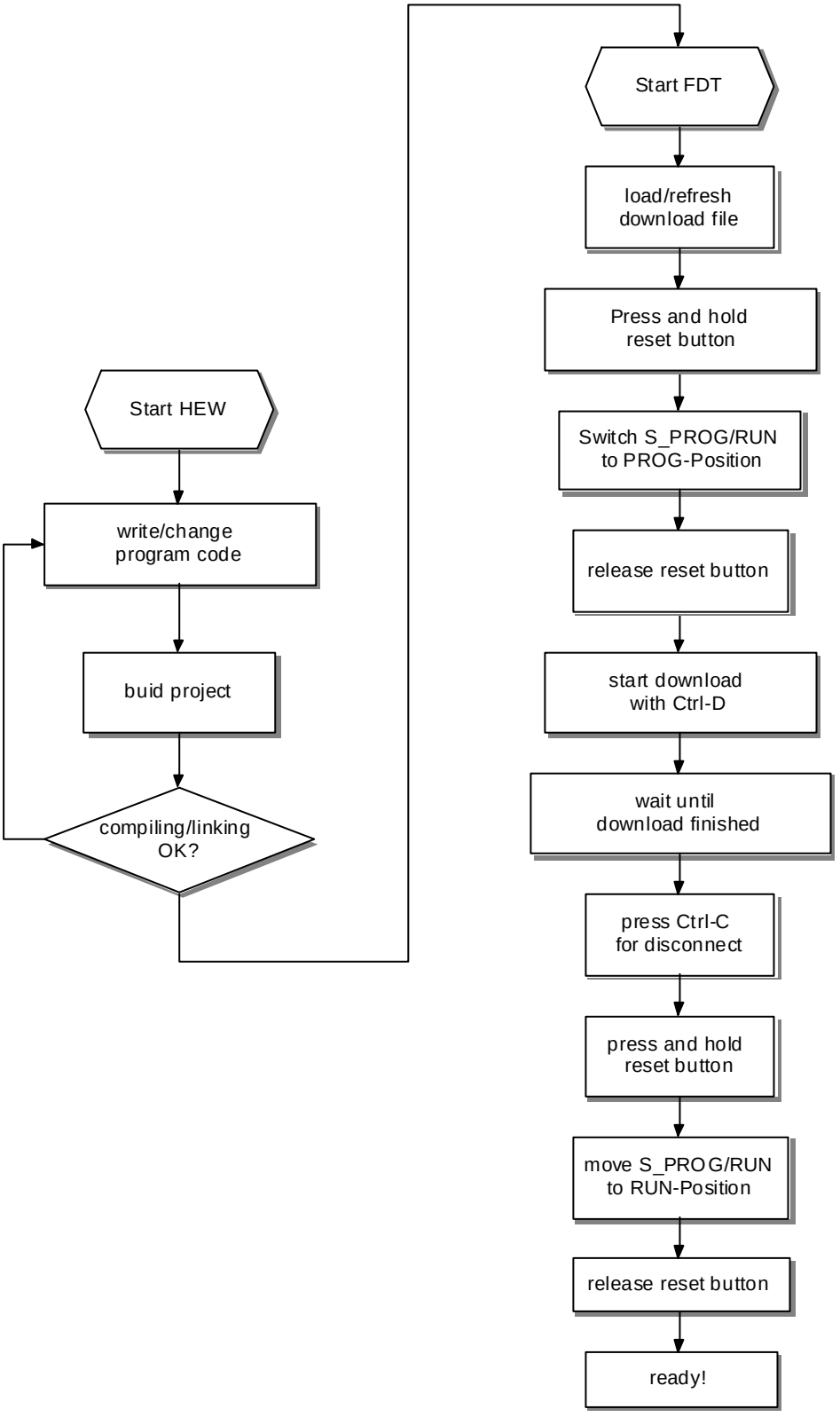
On target board, move Prog/Run-switch to run position (right) press down the reset button and release reset button.

Congratulations! Now your first program is running!

You will see the LED's flickering.

Now you can do some additional functions in HEW. After compiling and linking only go to FDT, update your download file with the command Freshen all Target files (Ctrl-T), reconnect the link and repeat the download process.

2.3 Workflow


Start HEW
write/change program code
buid project
compiling/linking OK?
Start FDT
load/refresh download file
Press and hold reset button
Switch S_PROG/RUN to PROG-Position
release reset button
start download with Ctrl-D
wait until download finished
press Ctrl-C for disconnect
press and hold reset button
move S_PROG/RUN to RUN-Position
release reset button
ready!

3 Examples

MSC-TEB1 is provided with some demonstration code.

On the supplied CD-R you should find a complete prepared workspace for HEW.

\examples\demoapp\demoapp.hws

Please copy the complete directory to your hard disk in a directory c:\H8TinySDK, so you will finally have the following directory (per example) “c:\H8TinySDK\examples\demoapp\” with all application notes included.

Then start HEW and select “open existing workspace”. Select one of the projects and do your exercises.

For all projects we need the same header file containing some definitions and the include file for the target microcontroller H8/3664F. So if you want to work with these files don’t forget to include the file “mydefs.h” first in your project file:

```
#ifndef _MYDEFS_H_
#define _MYDEFS_H_

#define CPU_CLK  9830400            // select clk for diff. calc.

#ifndef NULL
#define NULL 0x00
#endif

#ifndef FALSE
#define FALSE 0x00
#endif

#ifndef TRUE
#define TRUE 0x01
#endif

typedef unsigned char u8;
typedef unsigned int u16;

#endif
```

3.1 Key's and LED's

The first demo program shows the usage of LEDs and keys on MSC-TEB1. For time-controlling we use TIMER_A as an periodic interval timer. The interrupt service routine (isr) is checking the state of the keys, actualising the LED port and reading out the AD1-channel to determine the running light speed. If you want to do some experiments, first check out to find if other LED pattern maybe in form of a table read out or calculate them by functions developed by yourself. If speed control should be changed, first change the calculation of the A/D-conversion value to timer ticks.

```
/******************************************************************/
/*                                                                */
/*  FILE        :KeysLEDs.c                                       */
/*  DATE        :Sun, Jun 16, 2002                                */
/*  DESCRIPTION :Main Program                                     */
/*  CPU TYPE    :H8/3664F                                         */
/*                                                                */
/*  This file is generated by Hitachi Project Generator (Ver.2.1).*/
/*                                                                */
/******************************************************************/

#ifdef __cplusplus
extern "C" {
#endif
void abort(void);
#ifdef __cplusplus
}
#endif

/*---------------------------------------------------------------
**  KeysLEDs.c contains some sample code for using LEDs and Key's
**  on TinyEvalBoard
**  in addition Timer_A is used for timer tick with irq
**-------------------------------------------------------------*/

#include "..\mydefs.h"                      // for all nec. includes
#include "iodefine.h"
#include <machine.h>

/* defines */
#define KEY_1  (u8)0x10
#define KEY_2  (u8)0x20
#define KEY_3  (u8)0x04
#define KEY_4  (u8)0x02
#define KEY_ALL       (KEY_1|KEY_2|KEY_3|KEY_4)
#define KEY_RELEASED  (u8)0x40
#define KEY_PROCESSED (u8)0x80

#define LED_SPEED_INIT(u8)4         // = 4/32 = 1/8s = 125ms

/* variables */
u8 KeyCode=0;
u8 LED_Out, LED_Dir, LED_Run, LED_Speed;

/* functions */
void KeyCheck(void)
{
    if ((IO.PDR1.BYTE & KEY_ALL) != KEY_ALL) // is any key pressed ?
    {
        if (!(IO.PDR1.BYTE & KEY_1)) KeyCode = KEY_1;
        else if (!(IO.PDR1.BYTE & KEY_4)) KeyCode = KEY_4;
        else if (!(IO.PDR1.BYTE & KEY_3)) KeyCode = KEY_3;
```

```
        else if (!(IO.PDR1.BYTE & KEY_2)) KeyCode = KEY_2;
    }
    else
    {
        KeyCode = KEY_RELEASED;                     // no, mark key_released
    }
}

void RunningLightUpdate(void)               // check for keypresse
{                                                       // and update LEDs
    u8 dummy;
    u16 adval;

    if (!(KeyCode & KEY_RELEASED))
    {
        if ((KeyCode & KEY_1)==KEY_1) LED_Dir = 1;
        else if ((KeyCode & KEY_4)==KEY_4) LED_Dir = 0;
        else if ((KeyCode & KEY_2)==KEY_2) LED_Run = 0;
        else if ((KeyCode & KEY_3)==KEY_3) LED_Run = 1;
        KeyCode |= KEY_RELEASED;
    }

    if (LED_Speed) LED_Speed--;                     // decrement speed counter
    if (!LED_Speed)                                         // if zero ...
    {
        LED_Speed = LED_SPEED_INIT;          // re init speed counter
        if (LED_Run)
        {
                if (LED_Dir)                            // right
                {
                        LED_Out >>= 1;                  // shift right
                        if (!LED_Out) LED_Out = 0x80;// if empty, set to 0x80
                }
                else
                {
                        LED_Out <<= 1;                  // shift left
                        if (!LED_Out) LED_Out = 0x01;// if empty, set to 0x01
                }
        }
    }
    IO.PDR8.BYTE = ~LED_Out;  // output (invert)
}

void PrepKeyPort(void)              // prepare key-port-bits
{
    IO.PMR1.BYTE &= ~KEY_ALL; // Port1 = I/O (0) for all keys
    IO.PCR1 &= ~KEY_ALL;              // Port1 = input(0) for all keys
    IO.PUCR1.BYTE |= KEY_ALL; // PullUps = on for all keys
}

void RunningLightInit(void)         // prepare LED-port and vars
{
    PrepKeyPort();
    IO.PDR8.BYTE = 0xff;              // all LED's off
    IO.PCR8 = 0xff;                         // all out's
    LED_Out = 0x01;                         // start value
    LED_Run = 0x01;                         // run
    LED_Dir = 0x00;                         // dir = left
    LED_Speed = LED_SPEED_INIT;      // start speed
}


/*************************************
    TimerA-Interrupt (1s)
    increments var c and output
    the value of c to LED's (inverted)
*************************************/
__interrupt(vect=19) void INT_TimerA(void)
{
    static u8 c;
    KeyCheck();                             // check for key pressed
    RunningLightUpdate();
```

```
    IRR1.BIT.IRRTA = 0;                     // clear irq-flag
}

/*************************************
    TimerA-Test
    setup : CLK/8 (=1µs @ 8MHz) at P10 (TMOW)
              1s-Irq-intervall @ SubClock (32.678 Hz)
*************************************/
void Timer_A_Init(void)
{
    IO.PCR8 = 0xff;                         // P8 = output
    TA.TMA.BYTE = 0x0c;                     // Reset PrescalerW
    TA.TMA.BYTE = 0x4b;                     // CLK/8 on P10, 1/32s-interval (Clk=Prescaler W)
    IO.PMR1.BYTE |= 0x01;             // set TMOW (P10) = Output
    IENR1.BIT.IENTA = 1;              // enable TimerA-Interrupt
    set_imask_ccr(0);                 // enable all interrupts
}

void main(void)
{
    RunningLightInit();               // Init key's and LEDs
    Timer_A_Init();                         // init & start timer_A
    while(1);                               // just wait ...
}


void abort(void)
{

}
```

3.2 LCD

One of the highlights of the MSC-TEB1 is the 2*16 character LCD with backlight. Simple functions are provided here to demonstrate the usage of the LCD. Please refer to the LCD manual for further information (e.g. commands, other character sets etc.).
The demo source contains some definitions to reset and initialise the display. Then we make some simple write outs.

```
/************************************************************************/
/*                                                                      */
/*  FILE        :LCDDemo.c                                              */
/*  DATE        :Sun, Jun 16, 2002                                      */
/*  DESCRIPTION :Main Program                                           */
/*  CPU TYPE    :H8/3664F                                               */
/*                                                                      */
/*  This file is generated by Hitachi Project Generator (Ver.2.1).      */
/*                                                                      */
/************************************************************************/

#include "..\mydefs.h"
#include "iodefine.h"

#ifdef __cplusplus
extern "C" {
#endif
void abort(void);
#ifdef __cplusplus
}
#endif

/*----------------------------------------------------------------------
** LCDDemo shows some funcions of the LCD on the TinyEvalBoard
** Please refer to LCD datasheet for further details
**----------------------------------------------------------------------*/

void wait(u16 wastetime)     // local LCD port delay
{
    while(wastetime--);
}

/*
    LCD-Port / Bits on TinyEvalBoard
    RS  = P75,  R/W    = P74,  EN     = P20,  DATA = P5
*/

// some defines for easy access
#define CLEAR_LCD_RS  (IO.PDR7.BIT.B5 = 0)
#define SET_LCD_RS    (IO.PDR7.BIT.B5 = 1)
#define CLEAR_LCD_RW  (IO.PDR7.BIT.B4 = 0)
#define SET_LCD_RW    (IO.PDR7.BIT.B4 = 1)
#define CLEAR_LCD_EN  (IO.PDR2.BIT.B0 = 0)
#define SET_LCD_EN    (IO.PDR2.BIT.B0 = 1)

#define LCD_DATA_PORT (IO.PDR5.BYTE)
#define LCD_DATA_CTRL (IO.PCR5)

#define LCD_OUT       0xff
#define LCD_IN 0x00

#define LCD_WAIT      {wait(100);}


void LCDWriteCmd(u8 cmd)            // write cmd to LCD port
{
```

```
    CLEAR_LCD_RS;
    CLEAR_LCD_RW;
    SET_LCD_EN;
    LCD_DATA_PORT = cmd;
    LCD_WAIT;
    CLEAR_LCD_EN;
    LCD_WAIT;
}

void LCDWriteData(u8 data)          // write data to LCD port
{
    SET_LCD_RS;
    CLEAR_LCD_RW;
    SET_LCD_EN;
    LCD_DATA_PORT = data;
    LCD_WAIT;
    CLEAR_LCD_EN;
    LCD_WAIT;
}

u8 LCDReadStatus(void)              // get the LCD status register
{
    u8 status;
    CLEAR_LCD_RS;
    SET_LCD_RW;
    LCD_DATA_CTRL = LCD_IN;
    SET_LCD_EN;
    status = LCD_DATA_PORT;
    CLEAR_LCD_EN;
    LCD_DATA_CTRL = LCD_OUT;
    return status;
}

void LCDInit(void)                  // init LCD
{
    u16 cnt=0;
    CLEAR_LCD_RS;
    CLEAR_LCD_RW;
    CLEAR_LCD_EN;
    IO.PCR7 |= 0x30;                // Set RS+RW = Output
    IO.PCR2 |= 0x01;                // Set EN = Output
    LCD_DATA_CTRL = LCD_OUT;        // Set DDR to Output

    LCDWriteCmd(0x38); // 8Bit-IF, 2 Lines, 5x7 character font
    while(--cnt);
    LCDWriteCmd(0x38); // 8Bit-IF, 2 Lines, 5x7 character font
    while(--cnt);
    LCDWriteCmd(0x38); // 8Bit-IF, 2 Lines, 5x7 character font
    while(--cnt);

    LCDWriteCmd(0x38); // 8Bit-IF, 2 Lines, 5x7 character font
    while(--cnt);

    LCDWriteCmd(0x0c); // DisplayOn, CursorOff, BlinkingOff
    LCDReadStatus();
    LCDWriteCmd(0x06); // Enter Mode, AutoIncrement
    LCDReadStatus();
    LCDWriteCmd(0x14); // MoveCursor right
    LCDReadStatus();
    LCDWriteCmd(0x80); // Set DD RAM Address = 0x00
    LCDReadStatus();

}


// writesomedata from 1st position in #line (0/1)
void LCDWriteLine(u8 line, const u8 *data)
{
    LCDWriteCmd(0x80 + line*0x40);   // select line
    while (*data)
    {
        LCDWriteData(*data);
```

```
        data++;
    }
}


void Delay(void)              // "manual" delay
{
    long z = 0x200000;
    while(--z);
}

const u8 Text1[17]  = "MSC H8-Tiny SDK+";
const u8 Text2[17]  = " *for H8/3664F* ";
const u8 Text3[17]  = "LowCostEvalBoard";
const u8 Text4[17]  = "+ Compiler =169$";


void LCDLoopMsg(void)
{
    while(1)                                        // do forever...
    {
        LCDWriteLine(0,&Text1[0]);    // display msgs
        LCDWriteLine(1,&Text2[0]);
        Delay();
        LCDWriteLine(0,&Text3[0]);
        LCDWriteLine(1,&Text4[0]);
        Delay();
    }
}

void main(void)
{
    LCDInit();                // init ports and LCD
    LCDLoopMsg();             // go to LoopMsg
}

void abort(void)
{

}
```

3.3 SCI

SCI is used here for a simple RS232 (V24) terminal connection. Please use a terminal program like HyperTerm (included in Windows), select Baudrate 9600 Baud, 8 Databits, No Parity and 1 Stopbit (8N1). After connection and setup, hit some keys and you will see a message responding on every keycode sent.

```
/************************************************************************/
/*                                                                      */
/*  FILE        :SCIDemo.c                                              */
/*  DATE        :Sun, Jun 16, 2002                                      */
/*  DESCRIPTION :Main Program                                           */
/*  CPU TYPE    :H8/3664F                                               */
/*                                                                      */
/*  This file is generated by Hitachi Project Generator (Ver.2.1).      */
/*                                                                      */
/************************************************************************/

#ifdef __cplusplus
extern "C" {
#endif
void abort(void);
#ifdef __cplusplus
}
#endif

#include "..\mydefs.h"       // see file for further include
#include "iodefine.h"

/* some defines */
#define TIE         0x80
#define RIE         0x40
#define TE          0x20
#define RE          0x10
#define MPIE        0x08
#define TEIE        0x04

#define CK_INT      0x00
#define CK_INT_OUT  0x01
#define CK_EXT      0x02

#define IS_SCI_RDF      (SCI3.SSR.BIT.RDRF)
#define CLEAR_SCI_RDF   (SCI3.SSR.BIT.RDRF = 0)

#define IS_SCI_TX_FREE  (SCI3.SSR.BIT.TDRE == 1)

#define V24_BRR(x)    ((unsigned char)(((CPU_CLK+16*x)/32/x) - 1))


void V24Init (u16 Baudrate)
{
 SCI3.SCR3.BYTE = 0x00;              // disable all
 SCI3.SSR.BYTE = 0x00;               // clear all errorbits
 SCI3.SMR.BYTE = 0x00;               // 8N1 + /1 clock
 SCI3.BRR = V24_BRR(Baudrate);       // set baud
 IO.PMR1.BYTE |= 0x02;               // P22 = TxD Output
 SCI3.SCR3.BYTE = (TE|RE|CK_INT);    // Ints und Data disabled, internal clock
}


u8 V24NewChar(void)                  // check for new char on V24
{
 if (IS_SCI_RDF)                     // Receive buffer full?
 {
  return TRUE;
```

```
 }
 return FALSE;
}

u8 V24GetChar(char* data)     // simple GetChar via V24
{
  u8 idx;
 if (IS_SCI_RDF)              // Receive buffer full?
 {
  *data = SCI3.RDR;           // yes, get data
  CLEAR_SCI_RDF;              // clear RDRF-Bit
  return TRUE;
 }
 return FALSE;
}


u8 V24PutChar(u8 c)           // simple PutChar via V24
{
  if (IS_SCI_TX_FREE)         // Tx register free ?
  {
    SCI3.TDR = c;             // yes, put data in tx register
    return TRUE;
  }
  return FALSE;
}


u8 V24Write(char *s)          // simple Write(string) via V24
{
  while (*s != 0)             // while not end of string
  {
    if (V24PutChar(*s) == TRUE) s++;  // PutChar
  }
  return TRUE;
}


u8 V24WriteLn(char *s)        // simple WriteLine (string + CR/LF)
{
  u8 ret = FALSE;
  ret  = V24Write(s);
  ret |= V24Write("\n\r");
  return ret;
}


void ShowUse(void)            // simple menu
{
    V24WriteLn("\n\n\rV24-DemoProgram");
    V24WriteLn("-1- Line 1");
    V24WriteLn("-2- Line 2");
    V24Write("make your choise :");
}


void main(void)
{
    char c;
    V24Init(9600);            // init sci with 9600Baud, 8N1
    ShowUse();                // display start msg
    while(1)                  // loop ...
    {
        if (V24GetChar(&c)==TRUE)
        {
               if (c=='1')
               {
                      V24WriteLn("\n\n\rGreat! This was '1'");
               }
               else if (c=='2')
               {
                      V24WriteLn("\n\n\rSuper! '2'");
```

```
                }
                else
                {
                        V24WriteLn("\n\n\rSorry! Only '1' or '2' are supported!");
                }
                ShowUse();
        }
    }

}


void abort(void)
{

}
```

3.4 A/D + PWM

This sample shows the usage of the A/D converter. We sample the voltage of P1/P2, filter it and show the result on the LCD. On D/A-Con you will see a reversed voltage at P2 – built with a RC-filter from TOW (P76).

```
/************************************************************************/
/*                                                                      */
/*  FILE        :AD_PWM.c                                               */
/*  DATE        :Sun, Jun 16, 2002                                      */
/*  DESCRIPTION :Main Program                                           */
/*  CPU TYPE    :H8/3664F                                               */
/*                                                                      */
/*  This file is generated by Hitachi Project Generator (Ver.2.1).      */
/*                                                                      */
/************************************************************************/

#ifdef __cplusplus
extern "C" {
#endif
void abort(void);
#ifdef __cplusplus
}
#endif

/*---------------------------------------------------------------------
** AD_PWM Demo shows some funcions of the A/D converter
** and the use of PWM (= inverse output from P2) at D/A-Con
**---------------------------------------------------------------------*/

#include "..\mydefs.h"              // with further includes!
#include <stdlib.h>                        // for abs()
#include "iodefine.h"

void wait(u16 wastetime)            // local LCD port delay
{
    while(wastetime--);
}

/*
    LCD-Port / Bits on TinyEvalBoard
    RS  = P75,  R/W    = P74,  EN     = P20,  DATA = P5
*/

// some defines for easy access
#define CLEAR_LCD_RS  (IO.PDR7.BIT.B5 = 0)
#define SET_LCD_RS    (IO.PDR7.BIT.B5 = 1)
#define CLEAR_LCD_RW  (IO.PDR7.BIT.B4 = 0)
#define SET_LCD_RW    (IO.PDR7.BIT.B4 = 1)
#define CLEAR_LCD_EN  (IO.PDR2.BIT.B0 = 0)
#define SET_LCD_EN    (IO.PDR2.BIT.B0 = 1)

#define LCD_DATA_PORT (IO.PDR5.BYTE)
#define LCD_DATA_CTRL (IO.PCR5)

#define LCD_OUT       0xff
#define LCD_IN 0x00

#define LCD_WAIT             {wait(100);}


void LCDWriteCmd(u8 cmd)            // write cmd to LCD port
{
    CLEAR_LCD_RS;
    CLEAR_LCD_RW;
    SET_LCD_EN;
    LCD_DATA_PORT = cmd;
```

```
    LCD_WAIT;
    CLEAR_LCD_EN;
    LCD_WAIT;
}

void LCDWriteData(u8 data)          // write data to LCD port
{
    SET_LCD_RS;
    CLEAR_LCD_RW;
    SET_LCD_EN;
    LCD_DATA_PORT = data;
    LCD_WAIT;
    CLEAR_LCD_EN;
    LCD_WAIT;
}

u8 LCDReadStatus(void)              // get the LCD status register
{
    u8 status;
    CLEAR_LCD_RS;
    SET_LCD_RW;
    LCD_DATA_CTRL = LCD_IN;
    SET_LCD_EN;
    status = LCD_DATA_PORT;
    CLEAR_LCD_EN;
    LCD_DATA_CTRL = LCD_OUT;
    return status;
}

void LCDInit(void)            // init LCD
{
    u16 cnt=0;
    CLEAR_LCD_RS;
    CLEAR_LCD_RW;
    CLEAR_LCD_EN;
    IO.PCR7 |= 0x30;          // Set RS+RW = Output
    IO.PCR2 |= 0x01;          // Set EN = Output
    LCD_DATA_CTRL = LCD_OUT;  // Set DDR to Output

    LCDWriteCmd(0x38); // 8Bit-IF, 2 Lines, 5x7 character font
    while(--cnt);
    LCDWriteCmd(0x38); // 8Bit-IF, 2 Lines, 5x7 character font
    while(--cnt);
    LCDWriteCmd(0x38); // 8Bit-IF, 2 Lines, 5x7 character font
    while(--cnt);

    LCDWriteCmd(0x38); // 8Bit-IF, 2 Lines, 5x7 character font
    while(--cnt);

    LCDWriteCmd(0x0c); // DisplayOn, CursorOff, BlinkingOff
    LCDReadStatus();
    LCDWriteCmd(0x06); // Enter Mode, AutoIncrement
    LCDReadStatus();
    LCDWriteCmd(0x14); // MoveCursor right
    LCDReadStatus();
    LCDWriteCmd(0x80); // Set DD RAM Address = 0x00
    LCDReadStatus();

}


// writesomedata from 1st position in #line (0/1)
void LCDWriteLine(u8 line, const u8 *data)
{
    LCDWriteCmd(0x80 + line*0x40);   // select line
    while (*data)
    {
        LCDWriteData(*data);
        data++;
    }
}
```

```
u16 Read_AD(u8 channel)
{
    u8 dummy;
    u16 adval;
    dummy = AD.CSR.BYTE;                    // dummy read
    AD.CSR.BYTE = 0x00;                         // reset A/D
    AD.CSR.BYTE |= (0x20 + (channel &0x01)); // start A/D, channel 0 or 1
    while (!(AD.CSR.BIT.ADF));              // wait conversion end
    if (channel & 0x01)       adval = AD.DRB;       // read A/D-value
    else adval = AD.DRA;
    return adval>>6;
}


u8 Line0[]  = " A/D#0=P1=0x    \0";
u8 Line1[]  = " A/D#1=P2=0x    \0";

// convert int to ASCII-HEX
void ShowHexValue(u16 code, u8 line)
{
    u8 *data, *text, c,d;
    if (line==0) text = &Line0[0];   // last digit = start address
    else text = &Line1[0];
    data = text+14;
    d=3;
    while (d)
    {
        *data = '0';                        // default = '0'
        c = code & 0x000f;                  // check digit
        if (c)                              // if > 0 chk for value
        {
               if (c < 10) *data = '0'+c;   // 0..9
               else *data = 'A'+c-10;       // a..f
        }
        data--;                             // next digit
        code >>= 4;
        d--;
    }
    LCDWriteLine(line,text);                // show result
}

void Delay(void)                            // "manual" delay
{
    long z = 0x010000;
    while(--z);
}


u16 oldval[2];

u16 Average(u8 channel, u16 adval)   // calculate av of last 15 values
{
    if ((abs)(oldval[channel]-adval)>10)
        oldval[channel]=adval;
    else
        oldval[channel] = ((oldval[channel]*15)+adval)>>4;
    return oldval[channel];
}


/*************************************
    TimerV-Test
    setup : CLK/8 (=1µs @ 8MHz)
               PWM-Output at TMOV (P76)
*************************************/
void Test_Timer_V(void)
{
    TV.TCRV0.BYTE = 0x08|0x01;              // Clear by CompMatchA; IntClk/8
    TV.TCRV1.BYTE = 0x01;                   // Clk/2, no external Trigger
    TV.TCSRV.BYTE = 0x08|0x01;              // 0=onCompMatchA, 1=onCompMatchB (output on P76)
```

```
    TV.TCORA = 100;                                 // set periode to 100 => 10.000Hz
    TV.TCORB = 75;                                  // set init dutycycle to 75%
}


void main(void)
{
    u16 val;
    LCDInit();                // init ports and LCD
    Test_Timer_V();           // for PWM-Output
    while(1)                  // do forever...
    {
        val = Average(0,Read_AD(0));
        ShowHexValue(val,0);
        val = Average(1,Read_AD(1));
        ShowHexValue(val,1);

        val /= 10;     // max. 1023/10 = 102
        TV.TCORB = (unsigned char)(val & 0xff);     // set PWM-output

        Delay();
    }
}


void abort(void)
{

}
```

3.5 AT-Keyboard-Interface

This demo shows the usage of the PS2 (mini-DIN) interface on MSC-TEB1. Please connect an AT-keyboard (MF102) to this port. You will see the keycodes, provided by the keyboard on the LCD. Please refer to the code table for keycode translation in your own projects.

```
/************************************************************************/
/*                                                                      */
/*  FILE        :AT_Keyb.c                                              */
/*  DATE        :Sun, Jun 16, 2002                                      */
/*  DESCRIPTION :Main Program                                           */
/*  CPU TYPE    :H8/3664F                                               */
/*                                                                      */
/*  This file is generated by Hitachi Project Generator (Ver.2.1).      */
/*                                                                      */
/************************************************************************/

#ifdef __cplusplus
extern "C" {
#endif
void abort(void);
#ifdef __cplusplus
}
#endif

/*----------------------------------------------------------------------
** AT-Keyb shows the PS2-Interface to an AT-Keyboard
**----------------------------------------------------------------------*/

#include "..\mydefs.h"              // with further includes!
#include "iodefine.h"
#include "machine.h"


void wait(u16 wastetime)     // local LCD port delay
{
    while(wastetime--);
}

/*
    LCD-Port / Bits on TinyEvalBoard
    RS  = P75,  R/W    = P74,  EN     = P20,  DATA = P5
*/

// some defines for easy access
#define CLEAR_LCD_RS  (IO.PDR7.BIT.B5 = 0)
#define SET_LCD_RS            (IO.PDR7.BIT.B5 = 1)
#define CLEAR_LCD_RW  (IO.PDR7.BIT.B4 = 0)
#define SET_LCD_RW            (IO.PDR7.BIT.B4 = 1)
#define CLEAR_LCD_EN  (IO.PDR2.BIT.B0 = 0)
#define SET_LCD_EN            (IO.PDR2.BIT.B0 = 1)

#define LCD_DATA_PORT (IO.PDR5.BYTE)
#define LCD_DATA_CTRL (IO.PCR5)

#define LCD_OUT       0xff
#define LCD_IN 0x00

#define LCD_WAIT              {wait(100);}


void LCDWriteCmd(u8 cmd)            // write cmd to LCD port
{
    CLEAR_LCD_RS;
    CLEAR_LCD_RW;
```

```
    SET_LCD_EN;
    LCD_DATA_PORT = cmd;
    LCD_WAIT;
    CLEAR_LCD_EN;
    LCD_WAIT;
}

void LCDWriteData(u8 data)          // write data to LCD port
{
    SET_LCD_RS;
    CLEAR_LCD_RW;
    SET_LCD_EN;
    LCD_DATA_PORT = data;
    LCD_WAIT;
    CLEAR_LCD_EN;
    LCD_WAIT;
}

u8 LCDReadStatus(void)              // get the LCD status register
{
    u8 status;
    CLEAR_LCD_RS;
    SET_LCD_RW;
    LCD_DATA_CTRL = LCD_IN;
    SET_LCD_EN;
    status = LCD_DATA_PORT;
    CLEAR_LCD_EN;
    LCD_DATA_CTRL = LCD_OUT;
    return status;
}

void LCDInit(void)            // init LCD
{
    u16 cnt=0;
    CLEAR_LCD_RS;
    CLEAR_LCD_RW;
    CLEAR_LCD_EN;
    IO.PCR7 |= 0x30;          // Set RS+RW = Output
    IO.PCR2 |= 0x01;          // Set EN = Output
    LCD_DATA_CTRL = LCD_OUT;  // Set DDR to Output

    LCDWriteCmd(0x38); // 8Bit-IF, 2 Lines, 5x7 character font
    while(--cnt);
    LCDWriteCmd(0x38); // 8Bit-IF, 2 Lines, 5x7 character font
    while(--cnt);
    LCDWriteCmd(0x38); // 8Bit-IF, 2 Lines, 5x7 character font
    while(--cnt);

    LCDWriteCmd(0x38); // 8Bit-IF, 2 Lines, 5x7 character font
    while(--cnt);

    LCDWriteCmd(0x0c); // DisplayOn, CursorOff, BlinkingOff
    LCDReadStatus();
    LCDWriteCmd(0x06); // Enter Mode, AutoIncrement
    LCDReadStatus();
    LCDWriteCmd(0x14); // MoveCursor right
    LCDReadStatus();
    LCDWriteCmd(0x80); // Set DD RAM Address = 0x00
    LCDReadStatus();

}


// writesomedata from 1st position in #line (0/1)
void LCDWriteLine(u8 line, const char *data)
{
    LCDWriteCmd(0x80 + line*0x40);   // select line
    while (*data)
    {
        LCDWriteData(*data);
        data++;
    }
```

```
}


#define cKEYCLK              0x40          // P16 (IRQ_2)
#define cKEYDATA      0x80          // P17

#define cKeyBufSize 16              // input keycode buffsize

u16 KeyCodeBuf[cKeyBufSize];  // input code buffer
u8 keyWriteIndex,keyReadIndex;       // buffer write/read index
u16 outval;
u8 outact;


// check for odd parity and stopbit
u8 OddParStopCheck(u16 data)
{
  u8 pcnt=0;
  u16 mask=0x0080;
  if (!(data & 0x0200)) return FALSE;        // check for stopbit
  while (mask)
  {
    if (data & mask) pcnt++;
    mask >>= 1;
  }
  if ((pcnt & 0x01) ^ (data & 0x0100)) return TRUE;
  return FALSE;
}


__interrupt(vect=16) void INT_IRQ2(void)
{
  static u8 cnt;
  static u16 val;

  if (outact)              /* do some output? */
  {
    if (outval & 0x0001) IO.PDR1.BYTE |= cKEYDATA;
    else IO.PDR1.BYTE &= ~cKEYDATA;
    outval >>= 1;
    if (!outval)
    {
      IO.PDR1.BYTE |= cKEYDATA;                          // set out=HIGH (1)
      IO.PCR1 &= ~cKEYDATA;                 // set portpin as input (0)
      outact=0;
    }
  }
  else                                      // process input data
  {
    val >>= 1;
    if (IO.PDR1.BYTE & cKEYDATA) val |= 0x0200;
    cnt++;
    if (cnt>=11)
    {
      if (OddParStopCheck(val)==TRUE)
      {
        KeyCodeBuf[keyWriteIndex] = val;
        keyWriteIndex++;
        if (keyWriteIndex >= cKeyBufSize) keyWriteIndex = 0;
        cnt = 0;
        val = 0;
      }
    }
  }
  IRR1.BIT.IRRI2 = 0;         // clear IRQ-Flag
}

void SendKeyBoard(u8 data)          // send data to keyboard
{
  u8 pcnt = 0;
  u8 mask = 0x80;
  outval = data | 0x0600;       // stopbit + clkbit(internal)
```

```
  while (mask)                  // calculate odd parity
  {
    if (mask & data) pcnt++;
    mask >>= 1;
  }
  if (!(pcnt & 0x01)) outval |= 0x0100;   // set parity bit
  IO.PDR1.BYTE &= ~cKEYDATA;                // set data=LOW
  IO.PCR1 |= cKEYDATA;                      // set as output(1)
  outact = 1;                   // start output action
}


u8 kbhit(void)
{
  if (keyReadIndex != keyWriteIndex) return TRUE;
  else return FALSE;
}

u16 GetKey(void)
{
  u16 KeyCode;
  KeyCode = KeyCodeBuf[keyReadIndex];
  keyReadIndex++;
  if (keyReadIndex >= cKeyBufSize) keyReadIndex = 0;
  return KeyCode;
}


char buffer[17] = " KeyCode : 0000 \0";     // msg buffer

// convert int to ASCII-HEX
void ShowCode(u16 code)
{
    char *data, c;
    data = &buffer[14];                     // last digit = start address
    while (code)
    {
        *data = '0';                // default = '0'
        c = code & 0x000f;          // check digit
        if (c)                              // if > 0 chk for value
        {
               if (c < 10) *data = '0'+c;   // 0..9
               else *data = 'A'+c-10;       // a..f
        }
        data--;                             // next digit
        code >>= 4;
    }
    LCDWriteLine(1,buffer);         // show result
}


void KeyTest(void)
{
    u8 c;
    u16 KeyCode;

    IO.PMR1.BYTE |= cKEYCLK;  // P16 irq-input
    IO.PMR1.BYTE &= ~cKEYDATA;       // P17 i/o-pin

    IEGR1.BYTE &= ~0x04;             // IRQ_2 on falling edge
    IENR1.BYTE |= 0x04;                     // enable IRQ_2

    set_imask_ccr(0);               // enable all interrupts

    LCDWriteLine(0, "PC-Keyboard-Test");
    LCDWriteLine(1, "press any key...");

    while (1)
    {
        if (kbhit())          // if new key ...
        {
               KeyCode = GetKey();   // get codes
```

```
                ShowCode(KeyCode);    // display code
            }
        }
}


void main(void)
{
    LCDInit();                // init ports and LCD
    KeyTest();                // go to keyboard test
}


void abort(void)
{

}
```

Table : Scan-Codes MFII-Keyboard

Numeric Keypad Key	Scan-Code Set 1		Scan-Code Set 2		Scan-Code Set 3	
	Make-Code	Break-Code	Make-Code	Break-Code	Code	Typ
Num	45	C5	77	F0-77	76	Make, Break
7	47	C7	6C	F0-6C	6C	Make, Break
4	48	C8	6B	F0-6B	6B	Make, Break
1	4F	CF	69	F0-69	69	Make, Break
/	E0-35	E0-B5	E0-4A	E0-F0-4A	77	Make, Break
8	48	C8	75	F0-75	75	Make, Break
5	4C	CC	73	F0-73	73	Make, Break
2	50	D0	72	F0-72	72	Make, Break
0	52	D2	70	F0-70	70	Make, Break
*	37	B7	7C	F0-7C	7E	Make, Break
9	49	C9	7D	F0-7D	7D	Make, Break
6	4D	CD	74	F0-74	74	Make, Break
3	51	D1	7A	F0-7A	7A	Make, Break
Del	53	D3	71	F0-71	71	Make, Break
-	4A	CA	7B	F0-7B	84	Make, Break
+	4E	CE	79	F0-79	7C	Make, Break
Enter	E0-1C	E0-9C	E0-5A	E0-F0-5A	79	Typematic

Main-Keypad Key	Scan-Code Set 1 Make-Code	Scan-Code Set 1 Break-Code	Scan-Code Set 2 Make-Code	Scan-Code Set 2 Break-Code	Scan-Code Set 3 Code	Scan-Code Set 3 Typ
^	29	A9	0E	F0-0E	0E	Typematic
1	02	82	16	F0-16	16	Typematic
2	03	83	1E	F0-1E	1E	Typematic
7	08	88	3D	F0-3D	3D	Typematic
8	09	89	3E	F0-3E	3E	Typematic
9	0A	8A	46	F0-46	46	Typematic
0	0B	8B	45	F0-45	45	Typematic
-	0C	8C	4E	F0-4E	4E	Typematic
=	0D	8D	55	F0-55	55	Typematic
<-(Backspace)	0E	8E	66	F0-66	66	Typematic
->| (Tab)	0F	8F	0D	F0-0D	0D	Typematic
q	10	90	15	F0-16	15	Typematic
w	11	91	1D	F0-1D	1D	Typematic
e	12	92	24	F0-25	24	Typematic
r	13	93	2D	F0-2D	2D	Typematic
t	14	94	2C	F0-2C	2C	Typematic
v	15	95	35	F0-36	35	Typematic
u	16	96	3C	F0-3C	3C	Typematic
i	17	97	43	F0-43	43	Typematic
o	18	98	44	F0-44	44	Typematic
p	19	99	4D	F0-4D	4D	Typematic
[	1A	9A	54	F0-55	54	Typematic
]	1B	9B	5B	F0-5B	5B	Typematic
Return	1C	9C	5A	F0-5A	5A	Typematic
CAPS-Lock	3A	BA	58	F0-58	58	Make, Break
a	1E	9E	1C	F0-1C	1C	Typematic
s	1F	9F	1B	F0-1B	1B	Typematic
d	20	A0	23	F0-23	23	Typematic
f	21	A1	2B	F0-2B	2B	Typematic
g	22	A2	34	F0-34	34	Typematic
h	23	A3	33	F0-33	33	Typematic
i	24	A4	3B	F0-3B	3B	Typematic
k	25	A5	42	F0-42	42	Typematic
l	26	A6	4B	F0-4B	4B	Typematic
;	27	A7	4C	F0-4C	4C	Typematic
'	28	A8	52	F0-52	52	Typematic
\	2B	AB	5D	F0-5D	5D	Typematic
left Shift	2A	AA	12	F0-12	12	Make, Break
<	56	D6	61	F0-61	13	Typematic
z	2C	AC	1A	F0-1A	1A	Typematic
x	2D	AD	22	F0-22	22	Typematic
c	2E	AE	21	F0-21	21	Typematic
v	2F	AF	2A	F0-2A	2A	Typematic
b	30	B0	32	F0-32	32	Typematic
n	31	B1	31	F0-31	31	Typematic
m	32	B2	3A	F0-3A	3A	Typematic
,	33	B3	41	F0-41	41	Typematic
.	34	B4	49	F0-49	49	Typematic
/	35	B5	4A	F0-4A	4A	Typematic
right Shift	36	B6	59	F0-59	59	Make, Break
Ctrl	1D	9D	14	F0-14	11	Make, Break
Left Win	5B	DB	E0-1F	E0-F0-1F	E3	Make, Break
Alt	38	B8	11	F0-11	19	Make, Break
Space	39	B9	29	F0-29	29	Typematic
AltGr	Strg+Alt	Strg+Alt	Strg+Alt	Strg+Alt	Strg+Alt	Make, Break
Right Win	5C	DC	Ê0-27	E0-F0-27	E7	Make, Break
Menu	5D	DD	E0-2F	E0-F0-2F	65	Make, Break

Table 1: Scan-Codes of MFII-keyboard, Main-Keypad

Function- and other keys	Scan-Code Set 1		Scan-Code Set 2		Scan-Code Set 3	
Key	Make-Code	Break-Code	Make-Code	Break-Code	Code	Typ
Esc	01	01	76	F0-76	08	Make, Break
F1	3B	BB	05	F0-05	07	Make, Break
F2	3C	BC	06	F0-06	0F	Make, Break
F3	3D	BD	04	F0-04	17	Make, Break
F4	3E	BE	0C	F0-0C	1F	Make, Break
F5	3F	BF	03	F0-03	27	Make, Break
F6	40	C0	0B	F0-0B	2F	Make, Break
F7	41	C1	83	F0-83	37	Make, Break
F8	42	C2	0A	F0-0A	3F	Make, Break
F9	43	C3	01	F0-01	47	Make, Break
F10	44	C4	09	F0-09	AF	Make, Break
F11	57	D7	78	F0-78	56	Make, Break
F12	58	D8	07	F0-07	5E	Make, Break
Print	E0-2A-E0-37	E0-B7-E0-AA	E0-12-E0-7C	E0-F0-7C-E0-F0-12	57	Make, Break
Scroll	46	C6	7E	F0-7E	5F	Make, Break
Pause	E1-1D-45-E1-9D-C5	Not available	E1-14-77-E1-F0-14-F0-77	Not available	62	Make, Break
Ins	E0-52	E0-D2	E0-70	E0-F0-70	67	Make, Break
Del	E0-53	E0-D3	E0-71	E0-F0-71	64	Typematic
Pos1	E0-47	E0-C7	E0-6C	E0-F0-6C	6E	Make, Break
End	E0-4F	E0-CF	E0-69	E0-F0-69	65	Make, Break
PgUp	E0-49	E0-C9	E0-7D	E0-F0-7D	6F	Make, Break
PgDn	E0-51	E0-D1	E0-7A	E0-F0-7A	6D	Make, Break
Arrow left	E0-4B	E0-CB	E0-6B	E0-F0-6B	61	Typematic
Arrow up	E0-48	E0-C8	E0-75	E0-F0-75	63	Typematic
Arrow down	E0-50	E0-D0	E0-72	E0-F0-72	60	Typematic
Arrow right	E0-4D	E0-CD	E0-74	E0-F0-74	6°	Typematic

Appendix A: CD-R content

Programs

HEW with Hitachi MCS tool chain
\programs\hew\

FDT (flash development toolkit)
\programs\fdt\

CodeLines (Hitachi code generator for device drivers)
\programs\CodeLines\

Examples

\examples\demoapp\

Demo

\examples\flashdemo\

Datasheets

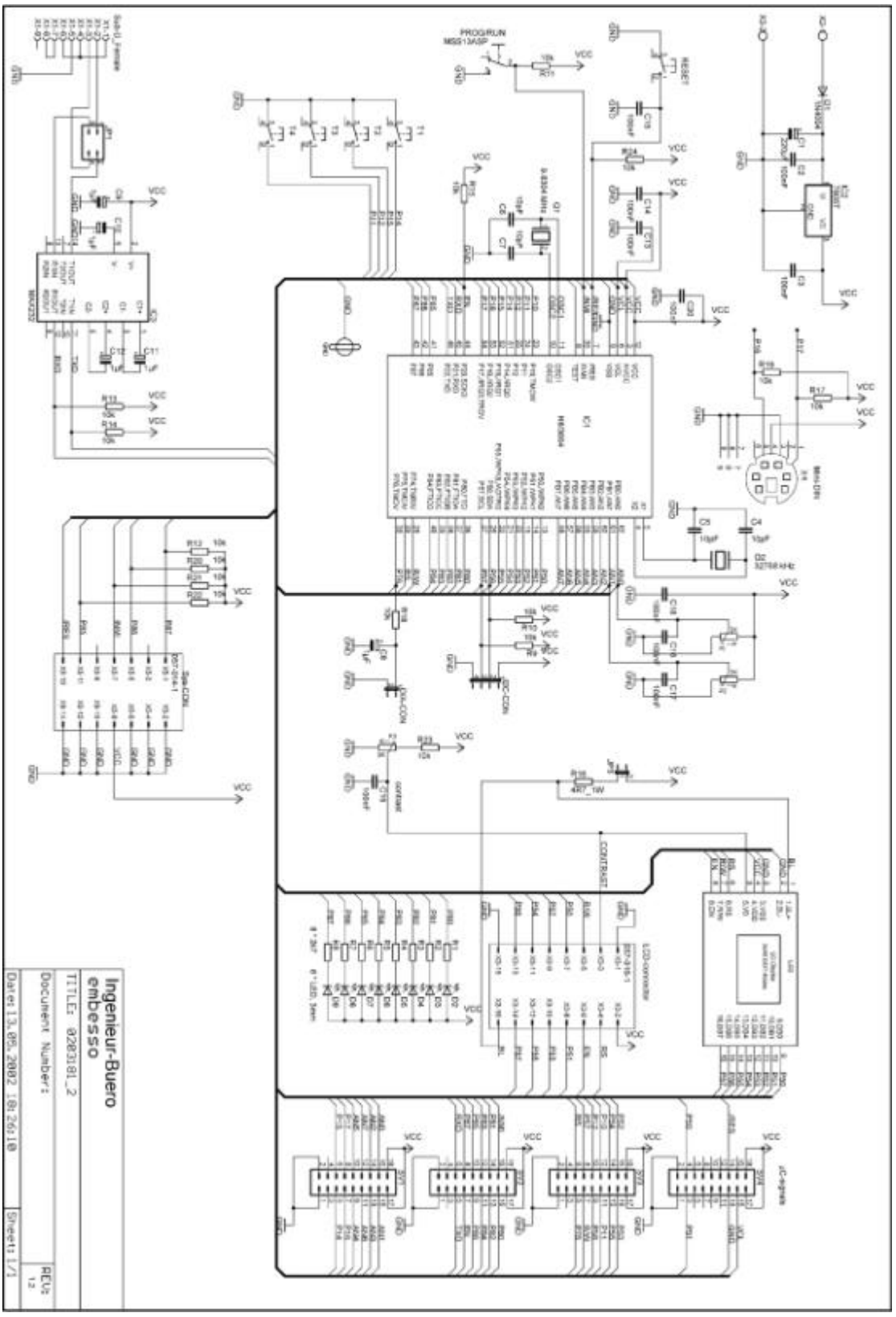
Tiny Hitachi H8/3664F hardware manual, H8 programming manual,
Tiny Application notes, LCD-Module,
\datasheets\

Documentation

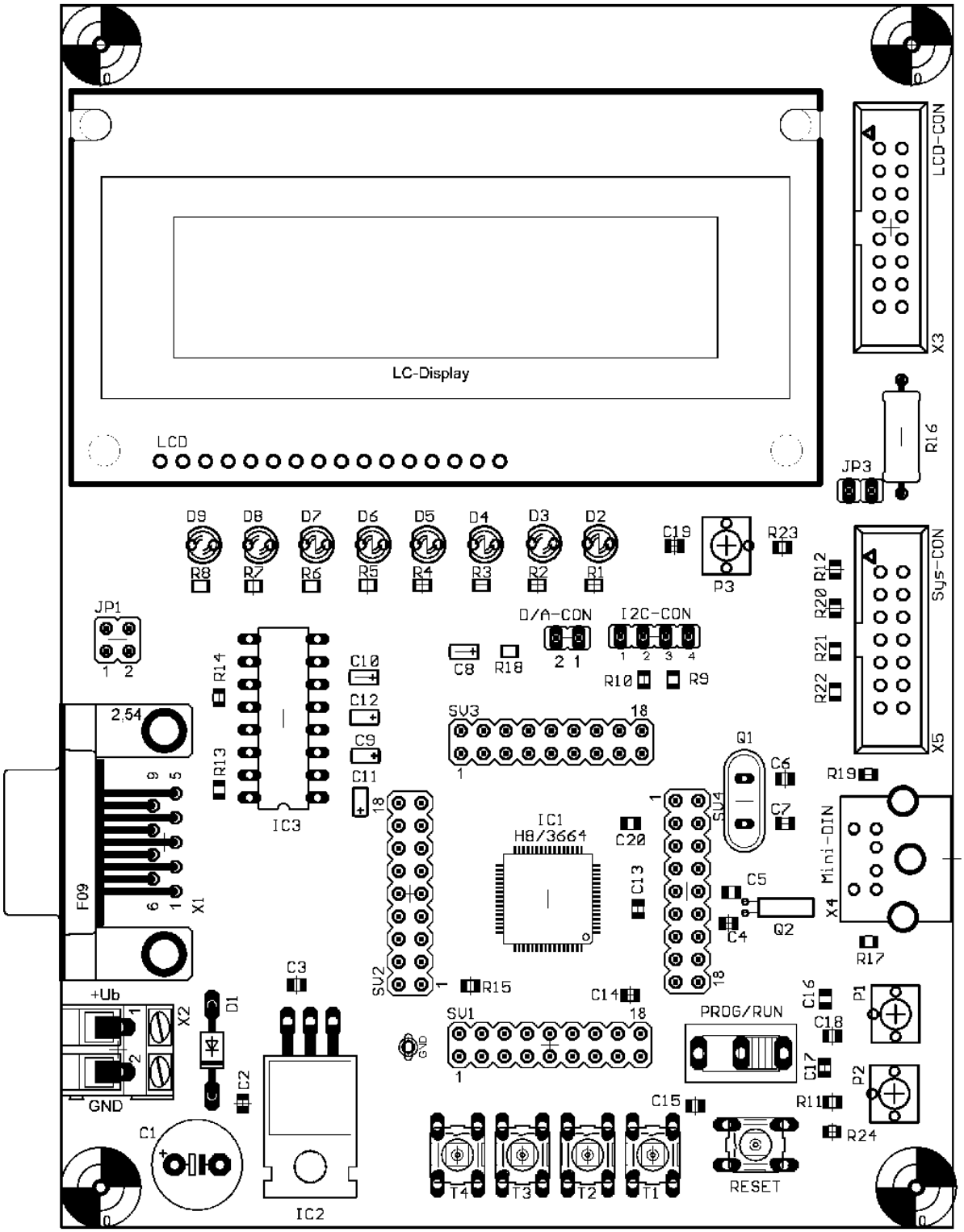
This manual as pdf
\documentation\

MSC-TEB1 board schematic
\documentation\schematic\

Appendix B: Schematic



Appendix C: Board layout



NOTES

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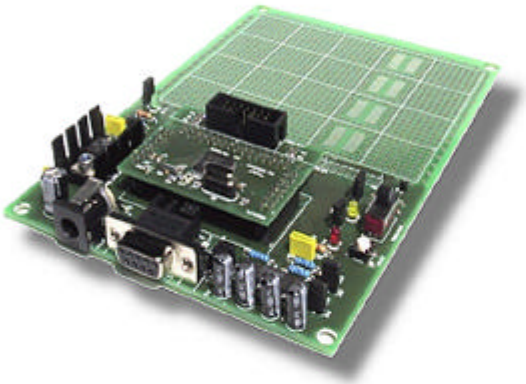
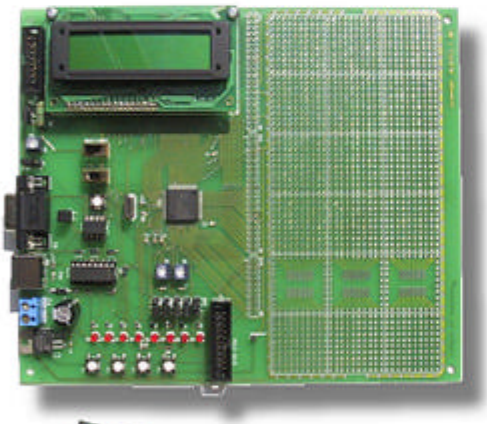


Tiny-Modules

CPU-Modules with Hitachi H8-Tiny-Controller

Basicboard

with wirewrap-field and a connector
for Tiny-Modules
(also available as complete kit)



H8/3048B-Evaluation-Board

with wirewrap-field, integrated LCD with
2*16 char and connector for external display

Integrated small Control-Board

with all usual connectors (kbd, RS232),
fully programmable (H8-Tiny onboard) etc...

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